Gulf of Cadiz Expedition
Contribution Number 3

XBT and XSV Data from the Gulf of Cadiz Expedition: R/V *Oceanus* Cruise 202

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Technical Report
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We thank Paul Stevens of the Fleet Numerical Oceanography Center for providing the T-6 XBTs. Larry Armi suggested using simultaneously dropped XBT and XSV probes to determine salinity and shared his experience with us. John Dunlap (APL-UW) developed much of the fall rate calculation software. This work was funded by the Office of Naval Research under Contract Number N00014-87-K0004.

ABSTRACT

Temperature profiles from expendable bathythermographs (XBTs) and sound speed profiles from expendable sound velocimeters (XSVs) were obtained during leg 1 of the Gulf of Cadiz Expedition, 4–19 September 1988, from R/V *Oceanus*. XBTs and XSVs were deployed around Ampere Seamount and Cape St. Vincent, Portugal. Salinity profiles have been calculated from simultaneously dropped pairs of XBTs and XSVs. This report describes the instrumentation used, discusses data acquisition and processing methods, and presents temperature, sound speed, and salinity profiles.

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1. INTRODUCTION

This report is the reference volume and data summary for expendable bathythermograph (XBT) and expendable sound velocimeter (XSV) data obtained during our leg 1 of R/V *Oceanus* Cruise 202, the Gulf of Cadiz Expedition, 4–19 September 1988. In addition, salinity profiles derived from simultaneously dropped pairs of XBTs and XSVs are presented.

The objectives of this expedition were to observe the vortices shed in the wake of Ampere Seamount, to survey eddies (Meddies) formed by the Mediterranean outflow near Cape St. Vincent, Portugal, and to study the structure and dynamics of the outflow plume west of the Strait of Gibraltar. The cruise consisted of two legs: our leg 1, from 4–19 September 1988, corresponded to Leg IV of *Oceanus* voyage 202; our leg 2, from 21–28 September 1988, corresponded to Leg V. XBTs and XSVs were deployed only on leg 1. In addition to XBTs and XSVs, expendable current profilers (XCPs) and expendable dissipation profilers (XDPs) were deployed, and CTD stations were taken during the cruise. During the Ampere Seamount component of the expedition, a radar transponder was moored, and four drifting buoys were tracked. The Gulf of Cadiz Expedition is described in detail by Kennelly et al., 1989a, and the CTD data are presented by Kennelly et al., 1989b.

The operational areas for the expedition included Ampere Seamount, the area around Cape St. Vincent, Portugal, and the Gulf of Cadiz west of the Strait of Gibraltar (Figure 1). The sampling pattern executed in the Meddy survey region, approximately delineated by the box in Figure 1, is shown in Figure 2. No XBT or XSV measurements were made along sections A–I.

The XBT drop locations are shown in Figures 3–7. The XSV drop locations are shown in Figures 8–10. XBTs 1 and 2 were test drops made shortly after leaving Funchal, Madeira (Figure 3). XBTs 3 through 27 were taken during the Ampere Seamount component of the experiment. After the radar transponder was moored on top of the seamount and CTD station 2 was taken, the ship headed to a point 23 n.mi. northeast of the mooring. Starting at this point, XBT sections were taken in a box pattern 60 km on a side around the seamount (Figure 4). Probes were deployed every half hour (10 km) around the circuit. No XSVs were deployed during the Ampere Seamount component of the expedition.

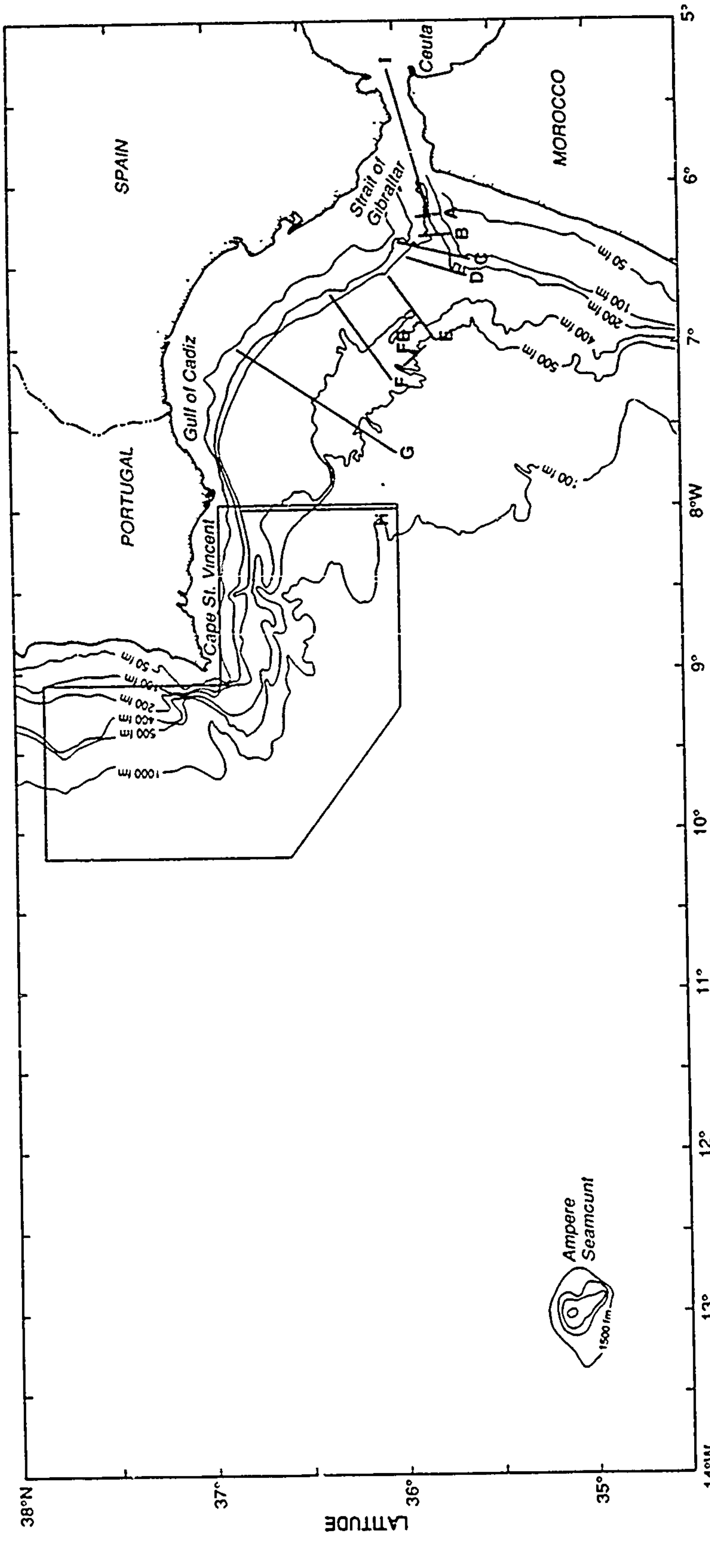

Figure 1. Operational areas for R/V Oceanus Cruise 202, Legs IV and V.

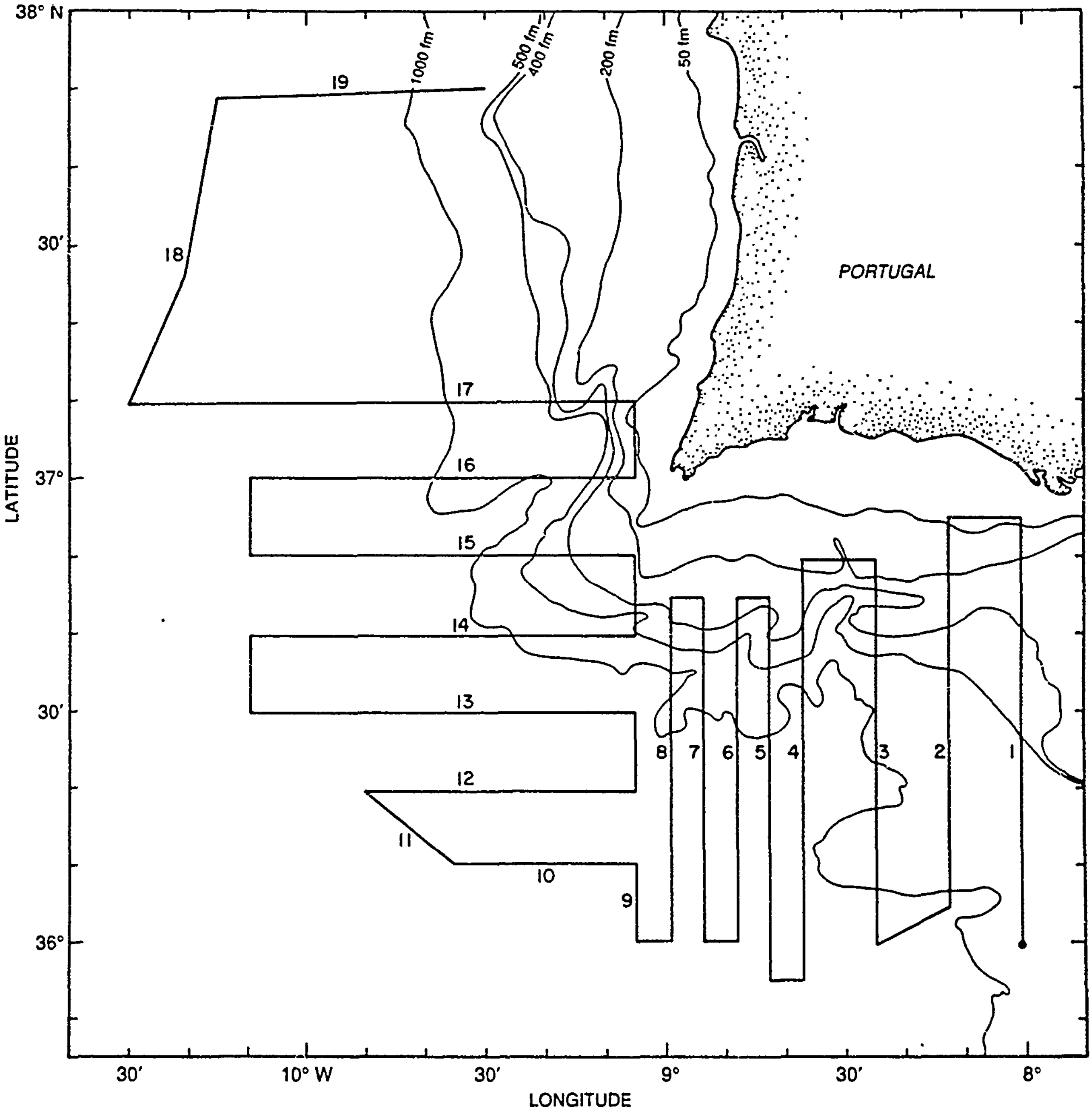

Figure 2. Survey pattern for Meddy component.

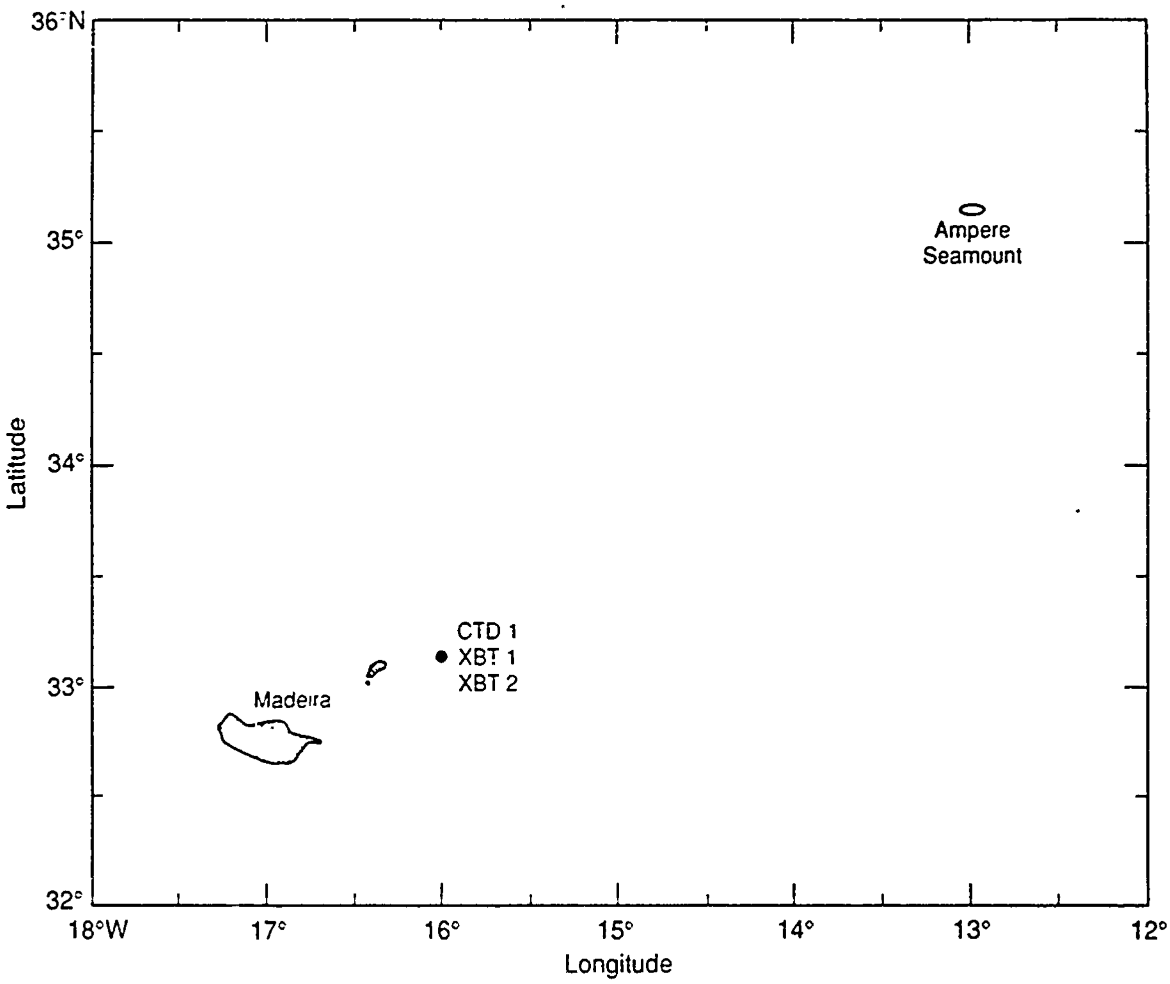

Figure 3. Test station locations.

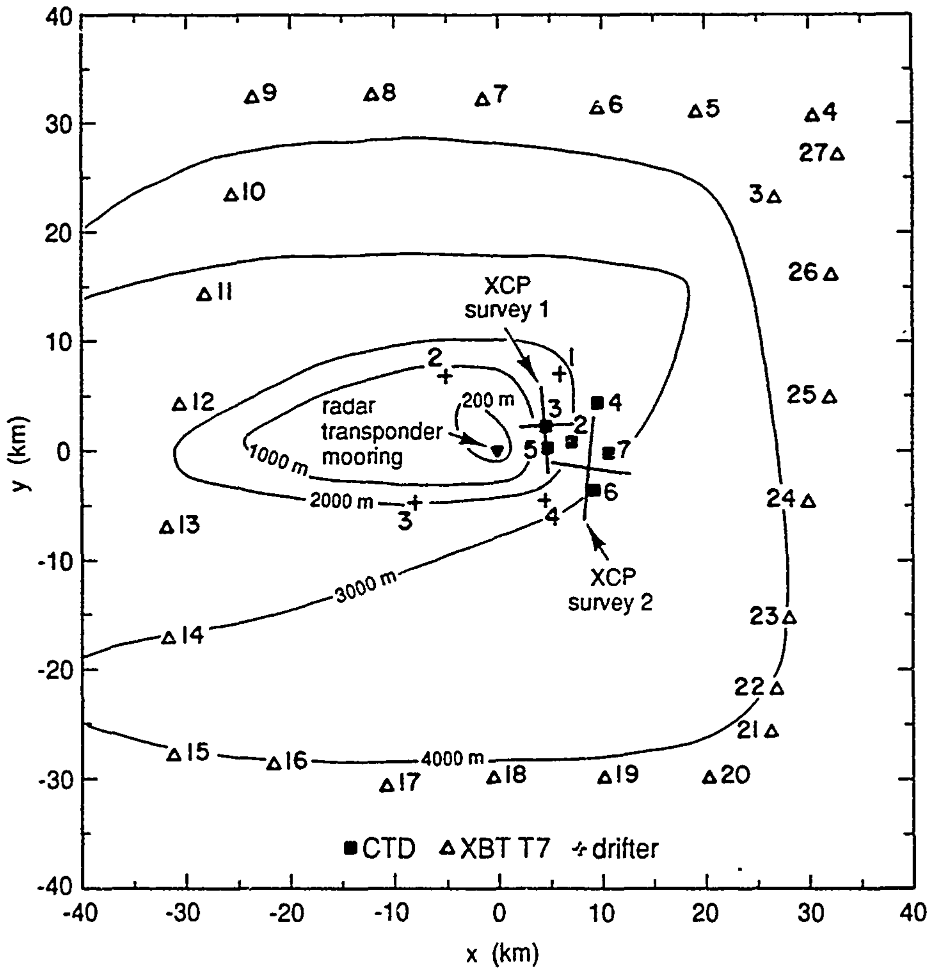

Figure 4. *XCP survey patterns and locations of XBT drops, CTD stations, and initial drifter deployments for Ampere Seamount component. Crude topography is also shown.*

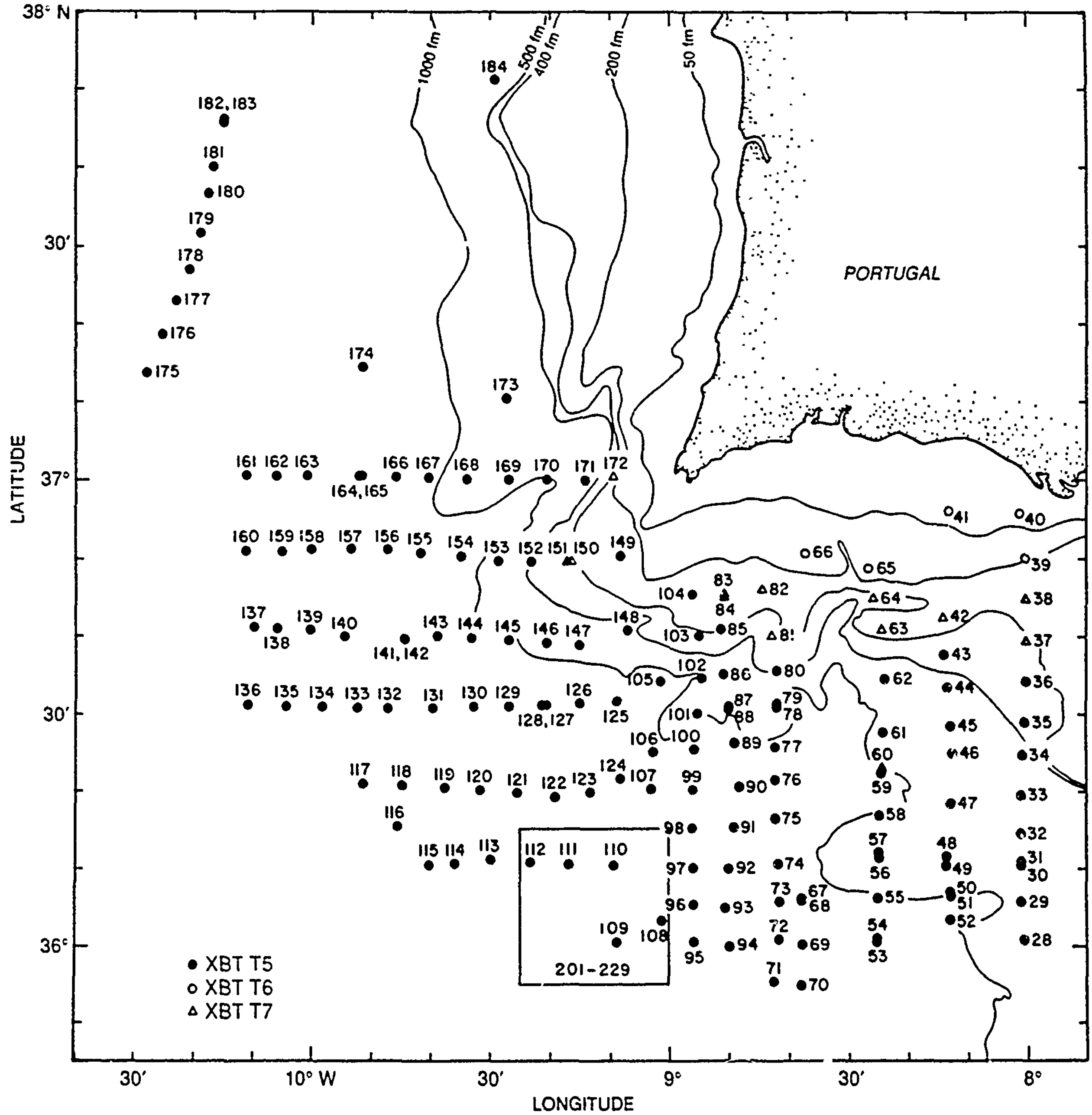

Figure 5. Location of XBT drops during Meddy component. Drops during survey of Meddy (201–229, boxed area) are shown in detail in Figure 7.

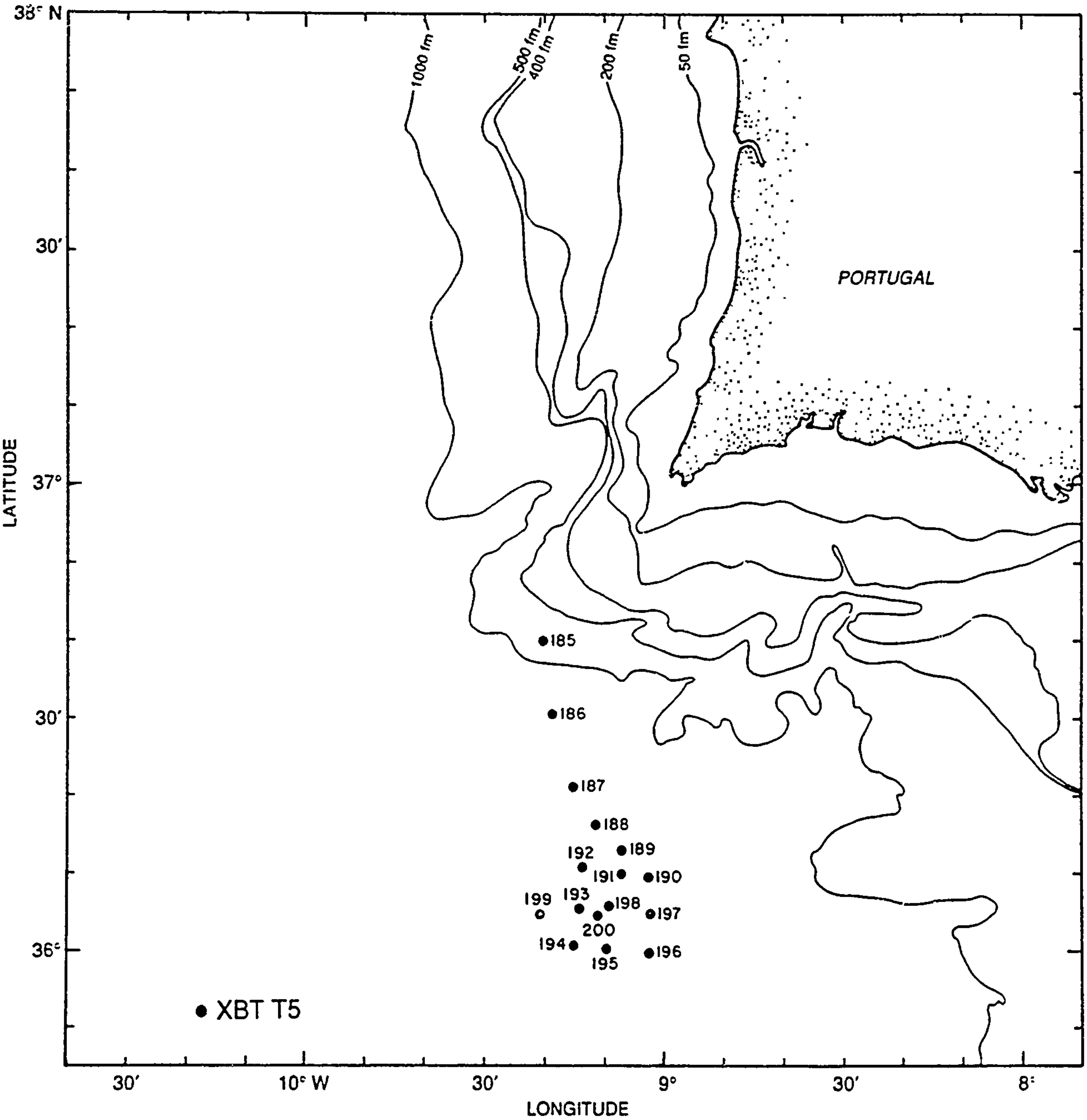

Figure 6. Location of XBT drops en route to Meddy and box pattern.

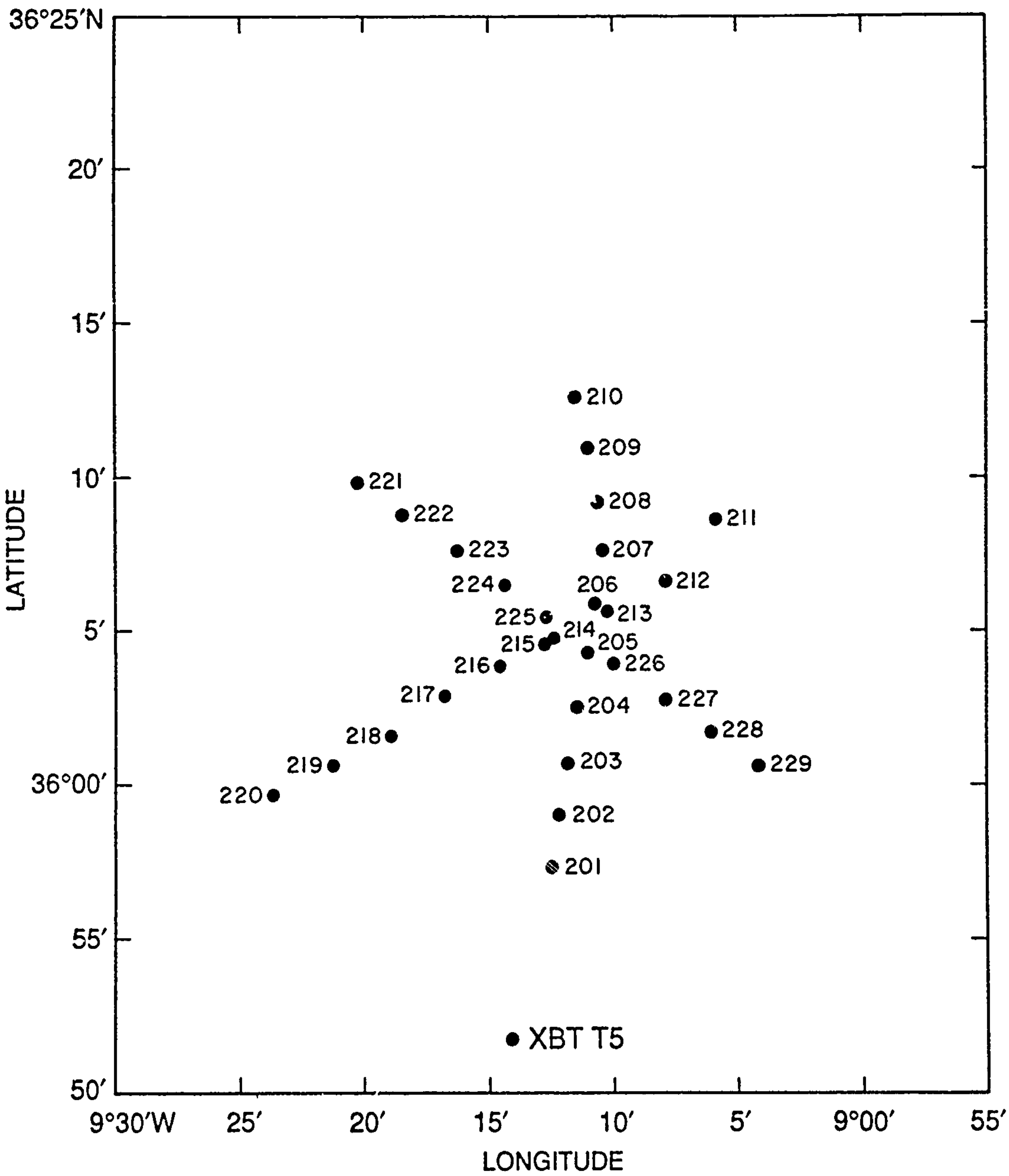

Figure 7. Location of XBT drops in Meddy.

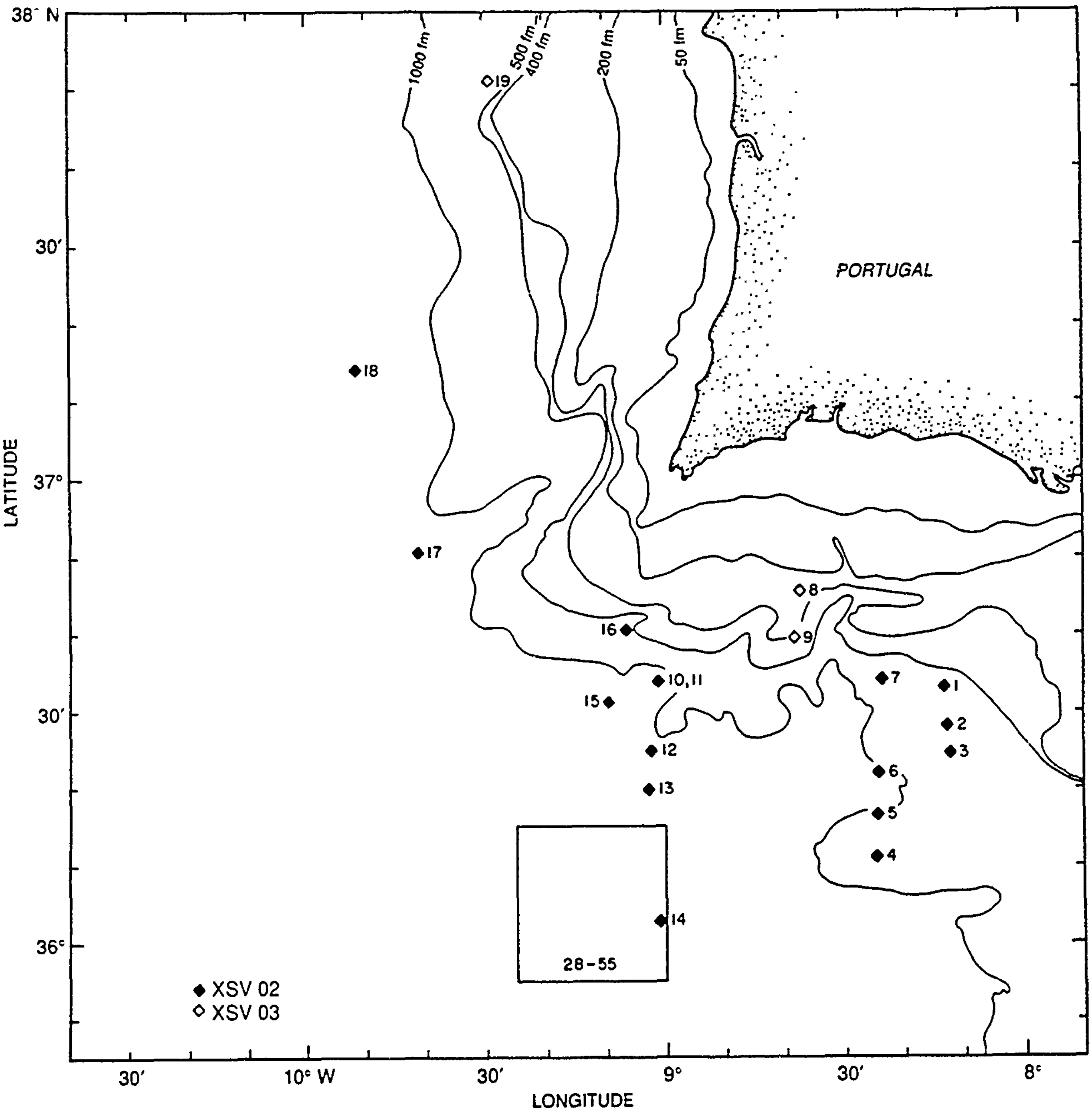

Figure 8. Location of XSV drops during Meddy component. Drops during survey of Meddy (28-55, boxed area) are shown in detail in Figure 10.

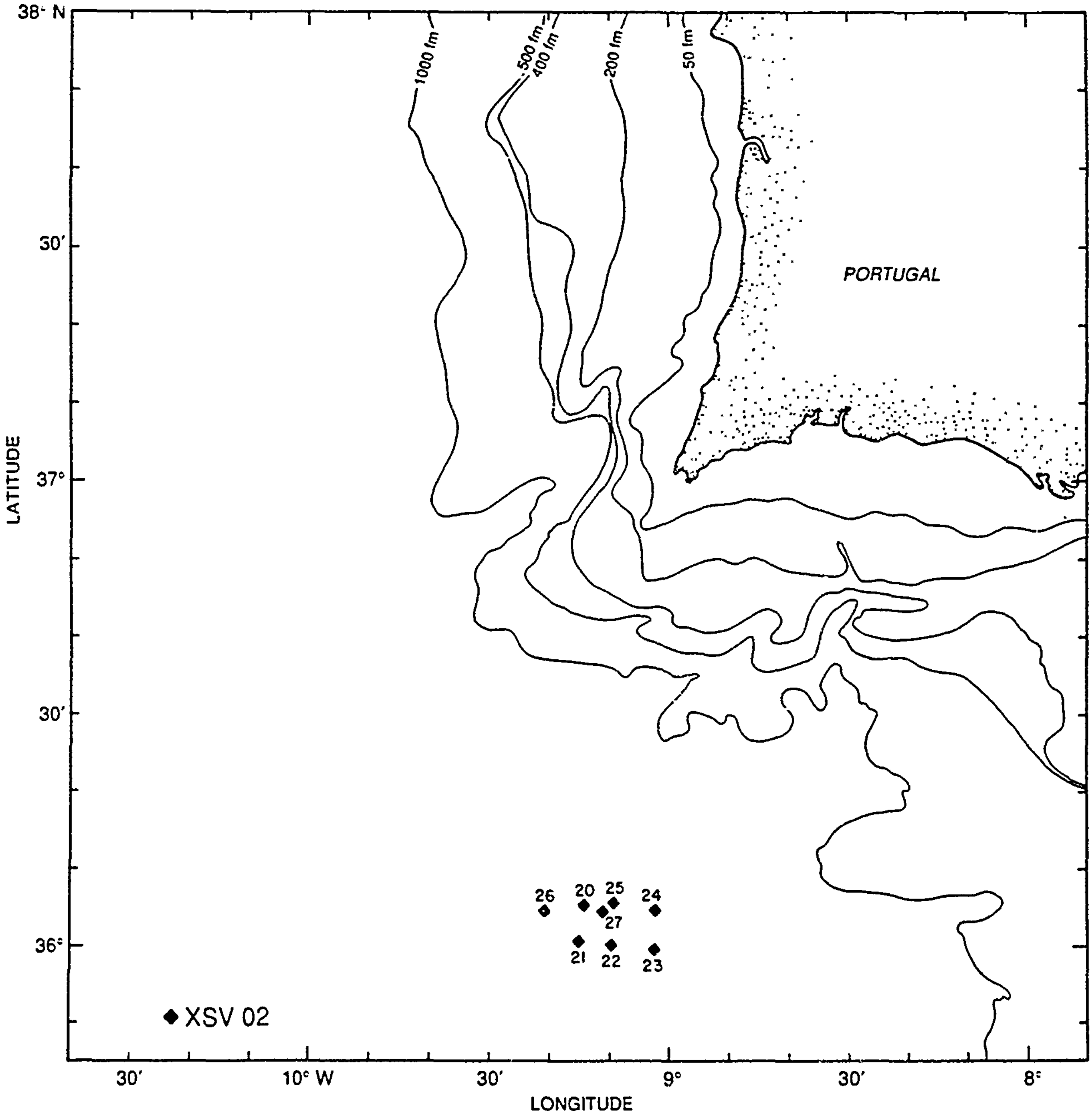

Figure 9. Location of XSV drops during box pattern.

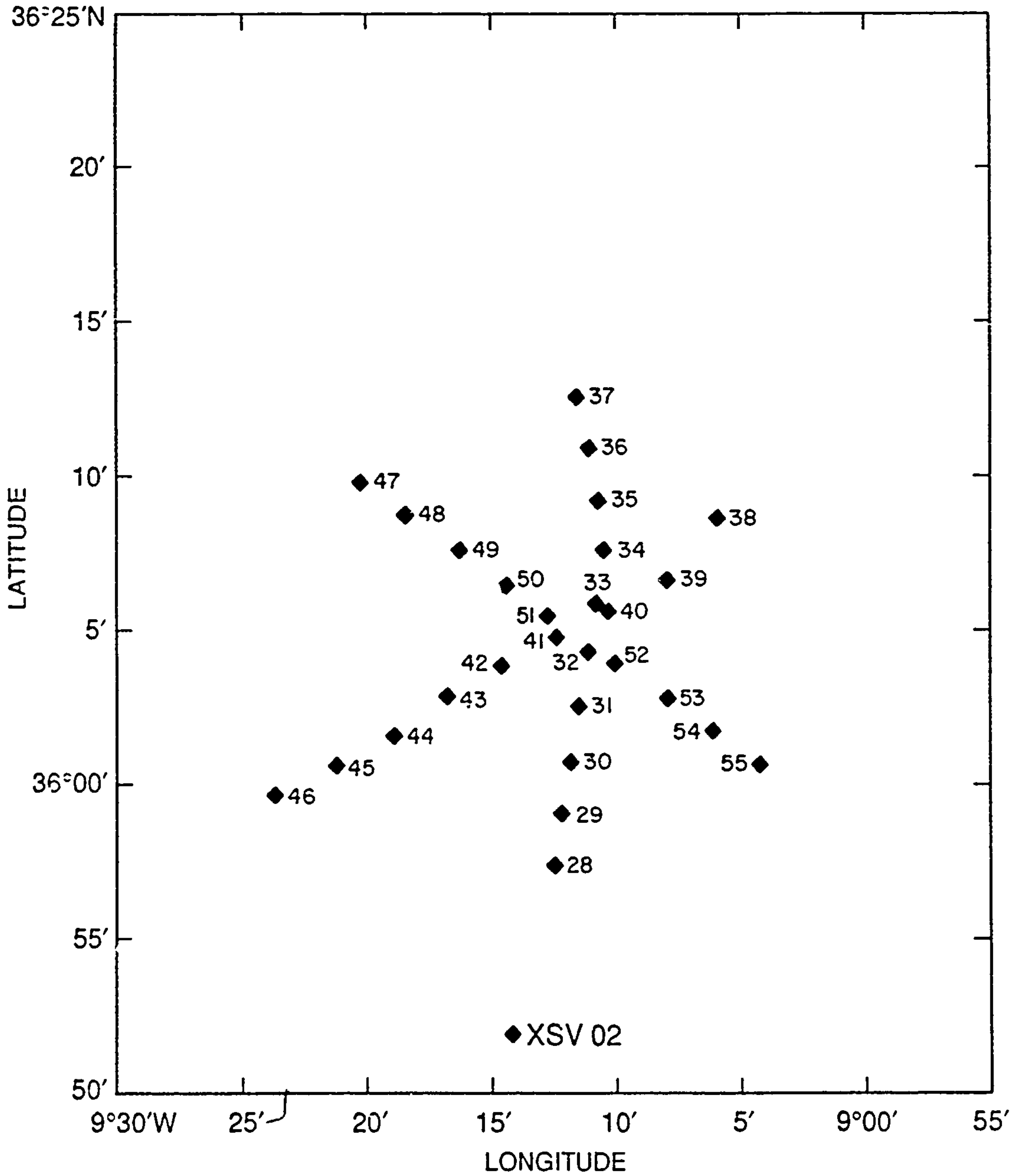

Figure 10. Location of XSV drops in Meddy.

XBTs and XSVs were deployed near Cape St. Vincent, Portugal, along the lines of the Meddy survey pattern (Figure 2). XBTs were dropped along all lines of the pattern (Figure 5), whereas XSVs were deployed only along lines 2, 3, 4, 8, 13, 14, 15, 17, and 19 (Figure 8). Problems were encountered with the XSVs during the early deployments. They would not process or display. By XSV drop 12, however, the problem had been identified as a manufacturing error. Many of the probes were misaligned, with the result that correct electrical contact was made by the launcher pins only 1/3 of the time. Subsequently, the probe alignment was checked, and if necessary the probes were realigned before launch.

After the Meddy survey pattern was completed and the data were reviewed, it was decided to study a Meddy that had been identified near CTD 25 (36°10.15′N, 9°02.1′W). En route to that position, XBTs were taken hourly starting with the crossing of line 14, with half hourly drops after crossing line 12 (Figure 6, XBTs 185–190). Little evidence of the 12°C core seen in CTD 25 was found on the way, so a box pattern survey (XBTs 191–200) was commenced. XSVs were also dropped during the box survey (Figure 9, XSVs 20–27). Finally, the Meddy was found about 10 n.mi. SW of CTD 25. A star pattern was then commenced to survey the Meddy using XCPs, XBTs (Figure 7), and XSVs (Figure 10).

No XBTs or XSVs were deployed on the second leg of the Gulf of Cadiz Expedition. Instead, the CTD profiler was used on all stations.

2. INSTRUMENTATION

2.1 XBTs

Three types of Sippican Inc. XBTs (T-5, T-6, and T-7), going to depths of 1830 m, 460 m, and 760 m respectively, were used during the cruise. Hand-held launchers inserted into deck-mounted launch tubes were located on both the starboard and port aft quarters of the ship. Each launcher was electrically tested for line resistance and isolation. The launcher initially provided by the ship failed these tests and was replaced with a new launcher. Each launcher was connected to a MK-9 receiver. In all, 229 XBTs were deployed. Appendix A gives the drop particulars.

Seven type T-6 probes were deployed during the cruise, and all provided good data. Forty T-7s were deployed, with a 90% success rate: two did not provide good data, and two did not provide data to full depth. The T-5 success rate was somewhat disappointing—82%, or 150 good drops out of 182. The failure modes were as follows: 13 yielded no good data, 13 did not provide data to full depth, 3 had obvious temperature offsets, 2 were noisy, and 1 contained temperature jumps.

2.2 XSVs

Two types of Sippican Inc. XSVs (XSV-02 and XSV-03), going to depths of 2000 m and 850 m respectively, were used during the cruise. The same launchers and MK-9 receivers (with the addition of XSV boards) were used for the XSVs as for the XBTs. In all, 55 XSVs were deployed. Appendix B gives the drop particulars.

During the first few deployments, the XSVs would not process or display. When an XSV-02 (slowfall type) was launched, it neither started the MK-9 nor provided ac signals more than 10 mV. Better electrical grounds were placed on the MK-9; however, the new grounds did not seem to solve the problem. Next, the XSV boards were swapped between MK-9 units. The next XSV-02 (XSV 5) worked well, giving voltages of more than a volt.

However, the XSV failure problem recurred. Seldom were the proper prelaunch voltages measured from the MK-9 or usable signals received from the falling probes. The condition of the launcher and cables was repeatedly checked. For a while it was thought one or both of the XSV boards were damaged.

Closer examination of the XSVs revealed that the cannister was often improperly aligned with the shipboard spool. Evidently, the probes were assembled without regard to the notch on the cannister and the arrowhead on the spool. There are three connecting tabs on the cannister, allowing three different orientations between the cannister and spool. Because only one orientation permits the correct connections to be made at the launcher, the data return was poor. Seven probes failed before our discovery of the manufacturing error. The remaining probes were checked and realigned if necessary. The probes that were realigned are noted in Appendix B.

Of the 55 XSVs launched, 52 were type 02 and the remaining three were type 03. All the type 03s provided good data. The overall success rate for the type 02s was 79%. Before the manufacturing error was detected, seven of the first nine XSV-02s failed. After that, one failed to provide good data, another was noisy, and two did not provide data to full depth.

3. DATA ACQUISITION

An integrated acquisition program written in HP-Basic provided the acquisition of XCP, XBT, and XSV data in real time with a Hewlett Packard HP9020 computer. In this report only the XBT and XSV parts of the acquisition system will be discussed. Real-time processing and display of the data were also provided by the program. Data from up to three probes could be acquired and displayed simultaneously (with three co-running "partition" programs controlled by a fourth "master" program). Raw XBT and XSV data were archived onto floppy disk. In addition, as the data were acquired, the complete raw data stream was saved on an HP9144 magnetic cartridge tape drive connected to the HP9020. Raw data from XBTs and XSVs were stored along with a time stamp, an indication of the probe's type, and the partition that acquired the data.

A schematic of the acquisition system is shown in Figure 11. MK-9 XBT/XSV receivers were connected to partitions 2 and 3 on the computer via GPIB cable.

In case of computer failure, the data were also stored on VHS audio/video magnetic tape. One backup system was dedicated to the XBT/XSV data. The backup system consisted of a VCR, Sony model PCM-F1 digital audio processor (PCM stands for pulse code modulation; use of the PCM processor allowed us to record the two audio channels of XSV data on the video tracks of a VHS tape), and power adapter. The XBT and XSV data were sent to the backup system as four frequency-modulated signals. The XSV signals are FM signals to begin with. They needed only to be amplified and filtered to be recorded. The XSV data were passed through a digital audio processor and stored on the video tracks of a VHS tape. The XBT output was an analog voltage that was converted to an FM signal. The frequency range of the XBT FM signal was selected to use the frequency range of the air deployed XBT (AXBT), so that with a little work the AXBT card in the MK-9 receiver could be used to play through the backup data if needed (the standard AXBT output is an FM signal). The converted FM XBT data were stored on the two VHS audio tracks. Both MK-9s were modified to produce frequency-modulated voltages for recording the XBT data on VHS tape.

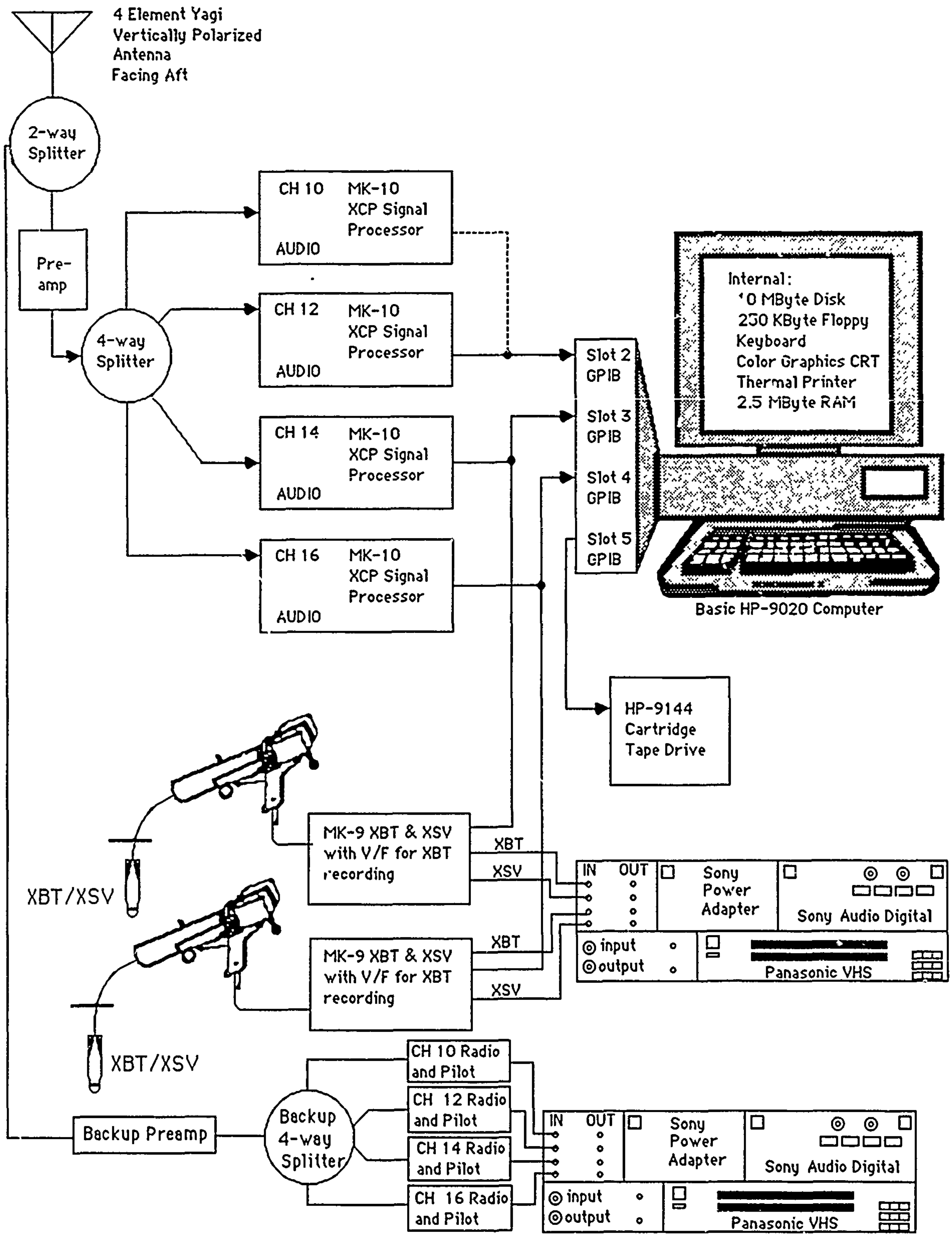

Figure 11. XCP/XBT/XSV acquisition system configuration.

4. AT-SEA DATA PROCESSING

4.1 XBT

The acquisition program provided a printout of the isotherm depths as the probe was falling. Hand-contoured sections of isotherms were then produced. Waterfall plots of the temperature profiles overlaid on computer-generated isotherm sections were produced while the acquisition program was paused. To obtain a graph of an individual XBT temperature profile, the floppy disk with the XBT raw data was removed from the HP9020 running HP-Basic (the acquisition computer) and transferred to the HP9020 running UNIX. The data were loaded onto the HP9020 UNIX, a decoding program written by John Dunlap was run on the data, and a profile was generated.

4.2 XSV

Individual sound speed profiles were obtained in the same manner as for the XBTs. When an XSV was compared with a simultaneously dropped XBT, it was noticed that features did not line up in depth exactly. Visual inspection of the XSV profiles showed ocean features to be 8% shallower than in comparable XBT profiles. The XBT depths were believed to be accurate based on the work of other investigators (Heinmiller et al., 1983; Seaver and Kuleshov, 1982). This was our first indication that the XSV fall rate might be significantly incorrect.

4.3 Calculation of Salinity

Once the data had been loaded into the HP9020 UNIX computer and decoded, salinity was calculated from simultaneously dropped XBTs and XSVs using a program written by John Dunlap. This program read both profiles, temperature and sound speed, interpolated each onto an equally spaced depth grid, and shifted the XSV profile to maximize its correlation with the XBT profile. Salinity was calculated based on an inversion of the Del Grosso (1974) sound speed equations. A more detailed discussion of a variation of this program is given in Sections 5.1 and 5.4.

5. POST-CRUISE DATA PROCESSING

5.1 Calibrations

To combine data from expendable probes (such as XBTs, XSVs, and XCPs) with CTD data for contouring and computing heat and salt transports, the depth needs to be calibrated against a standard. For the expendable probes used in this experiment, the depth (and thus the fall rate) of the probe is estimated as a quadratic function of time. The coefficients of the quadratic polynomial are empirically determined by Sippican Inc., the manufacturer of the probes. During the Gulf of Cadiz experiment, we had an opportunity to verify the depth estimates of the probes by comparing the high-wavenumber structure of their temperature or sound speed signal with that obtained by the Sea-Bird CTD unit. This process also gave us information about the random errors and systematic offsets in these variables. This section summarizes the computational procedure and presents the results. An additional comparison was made between the XSVs and the XBTs, since the data from these probes can be combined to estimate salinity.

Because the CTD's vertical variable is pressure and the expendable probe's variable is depth, a conversion is needed before the expendable probe's depth can be calibrated. Saunders and Fofonoff (1976) published a conversion method that consists of integrating the hydrostatic equation downward from the sea surface while accounting for the horizontal and vertical variations in the earth's gravitational field. For this analysis, the CTD data collected on the cruise were averaged into 10-dbar bins, and the vertical integration was performed for each cast. At each bin level, a ratio was formed between the computed depth (in meters) and the measured pressure (in decibars). The resulting ratio-pressure curves from all the casts were combined at each bin level to give a curve for the average ratio. An approximation to the average ratio curve is given by

$$\text{ratio (pressure)} = 0.9927 - 2.55 \times 10^{-6}\ \text{pressure} + 0.0073 \exp(-\text{pressure}/50).$$

Figure 12 shows the average ratio curve (steppy) and the approximate curve (smooth). The depth is found by multiplying the measured pressure by the ratio appropriate for that pressure. If the pressure is 1000 dbar, for example, the corresponding depth is 1000×0.9901, or 990.1 m. The maximum error in depth caused by using the approximate curve instead of the one for any particular CTD cast is about 0.5 m.

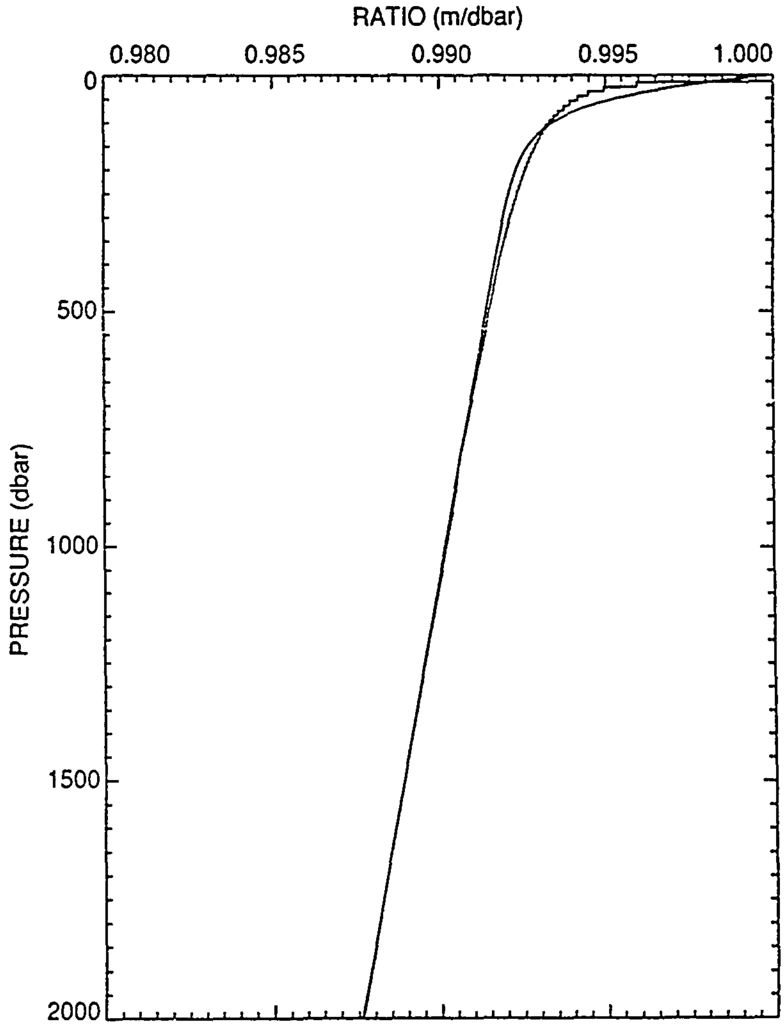

Figure 12. Relation between pressure and depth derived from the vertical integration of CTD data.

Pressure and depth will be used interchangeably in this section but with the understanding that the appropriate conversions have been made.

Software was developed by John Dunlap and Mark Prater to determine the relative depth offset as a function of depth between two drops or casts, assuming the instruments passed through similar ocean features on their descent. The vertical scales of the features used to compare the depths were between 10 and 100 m. To accent these features, the signal from the probe (either temperature or sound speed) was bandpass filtered to remove very high wavenumber noise and low wavenumber features. The program then shifted one profile with respect to the other and found the depth offset that maximized the correlation of the two over a limited depth range. This process was repeated for each depth value in the drop. Rather than compute the correlation for every offset possible, a "golden section search" (Press et al., 1986) was performed to find the maximum correlation. The correlation was assumed to be a smoothly varying function of offset, with a global maximum at the optimal offset. The optimized search procedure gave results comparable to those of the point-by-point search and ran 5 to 10 times faster. The maximum correlation achieved and the corresponding depth offset were recorded, as well as the temperature or sound speed differences in the nonfiltered signals at the optimum offset. Figure 13 shows an example of the program output for an XSV/XBT drop pair.

After the depth offset record was obtained for all the expendable probes, a second program was used that computed the mean and rms of the depth offset and the signal difference. During many drops, the maximum correlation at a depth bin was below 0.5, lowering the confidence that a good estimate of depth offset and signal difference was obtained. To keep these values from being included in the average and contributing to the rms, if the maximum correlation obtained for each depth bin during a drop was below a user defined minimum (usually 0.9), the depth offset and signal difference were not included in the subsequent calculation.

A probe/CTD pair was considered acceptable for analysis if the processed data from the probe passed visual inspection (no noticeable offsets, spikes, wire breaks, etc.) and the probe was dropped within 1 hour and within 1 n.mi. (2 km) of the CTD cast. These spatial and temporal constraints may appear harsh, especially compared with a previous error analysis by Heinmiller et al. (1983) which used XBT/CTD pairs from 15 to 50 km apart; however, because of the complex structure and interleaving of the Mediterranean

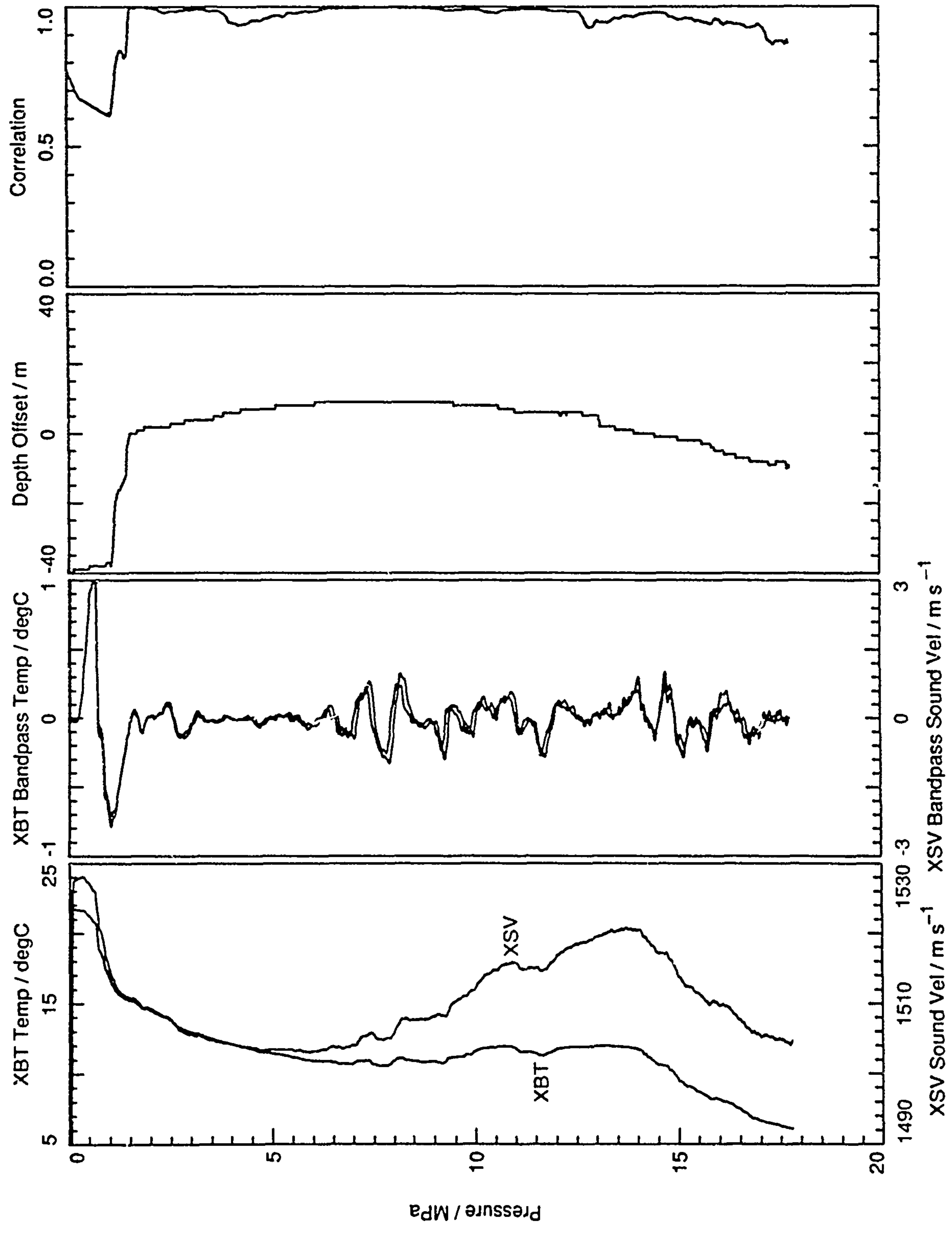

Figure 13. Output of program comparing an XSV/XBT drop pair.

outflow in the Gulf of Cadiz, small differences in time or position severely degraded the signal correlations.

This analysis was carried out for all the CTD and expendable probes. In this report, however, we will discuss only the XBT/CTD, XSV/CTD, and XBT/XSV comparisons. Four T-5 XBT/CTD pairs, one T-6 XBT/CTD pair, and one T-7 XBT/CTD pair were used in this analysis, but did not provide enough comparisons to estimate the depth offsets accurately. However, a systematic mean temperature offset of 0.075°C was observed throughout the drops, with an rms temperature variation of less than 0.1°C. The accuracy of the probe is given by Sippican Inc. to be ±0.15°C.

Three XSV-02/CTD and two XSV-03/CTD pairs were used in this analysis. During the cruise, it was noticed that features apparent in XSV data were roughly 8% shallower than similar features observed in the XBT or CTD data. A more accurate estimate could not be made at the time because of the small number of pairs. A better estimate of the depth offset is made later in this section. The analysis showed a 0.20 m s^{-1} offset in all the sound speeds. The sound sensor is probably the same for all XSV probes, so the same offset is expected for both types of XSVs. The accuracy of the probe is given by Sippican as ±0.25 m s^{-1}.

The XSV-02/XBT(T-5) drop pairs gave the highest quality intercomparisons because the two probes were dropped simultaneously with a spatial separation of only 10 m (the width of the fantail). XSV depths were multiplied by 1.08 before processing to partially correct the depth offset noticed on the cruise and to reduce the search for the maximum correlation. Table 1 gives the depth coefficients computed from this analysis along with those given by Sippican Inc. and those used on the cruise. The depth of the probe is given by

$$\text{depth} = \text{pcal0} + (\text{pcal1} \times t) + (\text{pcal2} \times t^2) ,$$

where t is the elapsed time in seconds since launch. The pcal's denote the coefficients of a quadratic equation relating the time of fall and depth of the probe and have no unique values without identification of the specific probe type. The analysis shows that the rms error between the XSV and the XBT depth varies linearly with depth from 1 m at the surface to 6 m at 1500 m.

Table I. XSV depth coefficients.

Coefficient	Sippican	Sippican (1.08 × Sippican)	Cadiz Cruise Analysis
pcal0	0.0	0.0	3.38
pcal1	5.5895	6.0367	5.8561
pcal2	−0.00147	−0.00159	−0.000883

This analysis assumes that the XBTs have the correct fall rate. The T-5 XBT/CTD comparison, although limited, supports this assumption. Subtracting 0.075°C from the T-5 XBT temperatures is recommended. There were too few comparisons with CTDs to recommend adjusting the T-6 or T-7 temperatures. The Cadiz cruise depth coefficients are recommended for any XSV-02 processing, along with adding 0.2 m s^{-1} to the sound speeds. Because of the limited data for XSV-03s, their depths have been assumed to be correct; however, since they use the same sound sensor as the XSV-02s, it is recommended that 0.2 m s^{-1} be added to the sound speeds.

5.2 Final XBT Processing

Many probes continued to transmit data after they hit the seafloor. Others failed before reaching their full depth capability. It is important to exclude such bad data from later analysis. Therefore a database was created of end-of-good-data depths. The value for the end depth was determined by scanning the unaveraged data values and finding the depth of the last good data point. The data were then passed to a program that accessed the end-depth database and retained only good data. Depths were converted to pressure using the following relation between pressure and depth determined from the Cadiz data:

$$\text{ratio} = 0.9927 + 2.55 \times 10^{-6} \times (\text{XBT depth}) + 0.0073 \times \exp(\text{XBT depth}/50)$$

$$\text{XBT pressure} = -(\text{XBT depth}/\text{ratio}) .$$

Processing of the T-5 XBT data involved an additional step: 0.075°C was subtracted from the temperature values. Finally, the data were gridded into 2 dbar values.

5.3 Final XSV Processing

A database of end-of-drop depths was also created for the XSV probes, and the same processing scheme was employed as for the XBTs. Type 02 XSV depths were corrected and converted to pressure in the following manner. First, we solved for time of fall by inverting the fall rate equation to obtain

$$t = \frac{-\mathrm{pcal1} + \sqrt{\mathrm{pcal1}^2 - 4(\mathrm{pcal2})(\mathrm{pcal0} + \mathrm{XSV\ depth})}}{2\mathrm{pcal2}} ,$$

where the pcal's are Sippican's XSV fall rate coefficients and have the values

pcal0 = 0.0
pcal1 = 5.5895
pcal2 = −0.00147.

Then we computed the new depth from time.

$$\text{New XSV depth} = -[\mathrm{pcal0} + (\mathrm{pcal1} \times t) + (\mathrm{pcal2} \times t^2)] ,$$

where these pcal's are the Cadiz cruise XSV coefficients determined in Section 5.1 and have the values

pcal0 = 3.38
pcal1 = 5.8561
pcal2 = −0.000883.

The "new XSV depths" were then converted to pressure in the same manner as the XBT depths. The type 03 XSV depths were not corrected; only the conversion to pressure was made. The sound speeds for both the type 02s and 03s were adjusted by adding 0.2 m s^{-1}. The data were then gridded into 2 dbar values.

5.4 Final Salinity Calculations

A conventional CTD would have taken 90 minutes to deploy, cast to 1800 m, and recover. To survey the Meddy rapidly, expendable temperature and sound speed probes were used in the hope that these data could be combined to compute salinity. The poorer data quality was more than offset by the ability to sample the feature quickly. The expendables were launched while the ship was slowed to 5 knots. This section summarizes the problems encountered and the method used to compute salinity.

Chen and Millero (1977) developed equations to calculate the speed of sound in seawater as a function of temperature, salinity, and pressure. For this study, their equations have been inverted to calculate salinity as a function of sound speed, temperature, and pressure (Appendix F). Chen and Millero's equations were chosen because their method is the most recent, encompasses the widest range of pressures, temperatures, and salinities, and is the UNESCO standard for computing sound speed (Fofonoff and Millard, 1983). In addition, the sound speed comparisons between the XSV and the CTD data and the salinity comparisons between the XSV/XBT pairs and the CTD data would then be consistent. The major problem with computing salinity with this inversion technique is that the value computed is very sensitive to changes in pressure and temperature. The sensitivities of the Chen and Millero inversion are given in Table 2, along with the accuracies needed to estimate salinity to within 0.1 psu. The accuracies of the XSV and XBT probes as given by Sippican Inc. (1983) are also presented.

Table II. Sensitivity of Chen and Millero inversion.

Variable	Sensitivity	Accuracy Needed for 0.1 psu	Accuracy of Probes
Depth	–0.0138 psu/dbar	7.2 dbar	2% of depth
Temperature	–2.8775 psu/°C	0.035°C	0.15°C
Sound Speed	0.8340 psu/m s^{-1}	0.12 m s^{-1}	0.25 m s^{-1}

The sound speed equation of Chen and Millero itself has an uncertainty of 0.2 m s^{-1}. For comparison, the sensitivities of the standard salinity computation from temperature, pressure, and conductivity are given in Table 3.

Because of the sensitivity of the Chen and Millero inversion to pressure, temperature, and sound speed, computing salinity from an expendable conductivity cell of moderate accuracy is far better than computing it from an expendable sound speed probe with very good accuracy. However, we will do the best with what we have.

Table III. Sensitivity of standard salinity computation.

Variable	Sensitivity	Accuracy Needed for 0.1 psu
Depth	−0.0004 psu/dbar	250 dbar
Temperature	−0.9145 psu/°C	0.11°C
Conductivity	9.7095 psu/S m^{-1}	0.01 S m^{-1}

To minimize the depth offset between the XBT and XSV data, we used the actual offsets found by the depth analysis for specific probe pairs instead of the depth coefficients found in Section 5.1. A polynomial was fit to the offset data so that regions of low correlation would be smoothed over. The depths of the XSV probes were then corrected using the polynomial fit, and the output was gridded to 2 m (the same as the output of the depth analysis). The salinity was then computed from the temperature, sound speed, and pressure (which is computed from depth) and gridded again on a larger scale (bin size 20 dbar, step size 2 dbar) for increased smoothing. At this point, we noticed that the salinity profile computed from the XBT/XSV data often had the same structure as that computed from the CTD data but was offset. To correct the offset, we computed the average salinity at the 300 dbar and 1600 dbar levels from the CTD data nearest the XSV/XBT pairs. These depths were chosen because they were above and below the effect of the Mediterranean outflow for most of the casts. The XSV/XBT salinities were then corrected so that they matched the CTD average of 35.75 psu for those two levels. The rms error in using the average salinity value at those depths is about 0.04 psu. The salinities were regridded (bin size 50 dbar, step size 2 dbar) for the final plots.

Overall, we were able to compute salinity fairly well from XSV and XBT data. Out of 55 XSVs dropped, 47 returned data. Of those, five were not dropped concurrently with a working XBT, leaving 42 usable drop pairs. Of those, 29 yielded good quality profiles and 13 poor quality. Quality was judged subjectively, based on how well the temperature versus salinity curves calculated for the expendable drop pairs resembled those obtained from nearby CTD casts. Good quality XSV and XBT data occasionally resulted in poor quality salinity values due to the extreme sensitivity of the inversion equations to temperature and sound speed, whereby seemingly inconsequential deviations in those variables lead to very wrong estimates of salinity. The results are summarized in Table 4.

Table IV. Summary of salinity results obtained from XSV/XBT drop pairs.

XSV No.	Data Quality	XBT No.	Data Quality	Salinity Quality	XSV No.	Data Quality	XBT No.	Data Quality	Salinity Quality
1	Fail			Bad	31	Good	204	Good	Good
2	Fail			Bad	32	Fail	205	Good	Bad
3	Fail			Bad	33	Good	206	Good	Poor
4	Fail			Bad	34	Good	207	Poor	Poor
5	Good	58	Good	Good	35	Good	208	Good	Good
6	Fail			Bad	36	Good	209	Fail	Bad
7	Fail			Bad	37	Good	210	Good	Good
8	Good		-	Bad	38	Good	211	Good	Good
9	Good		-	Bad	39	Poor	212	Good	Poor
10	Fail			Bad	40	Good	213	Good	Good
11	Good	105	Good	Poor	41	Good	215	Fail	Bad
12	Good	106	Poor	Poor	42	Good	216	Poor	Poor
13	Good	107	Good	Good	43	Good	217	Good	Good
14	Good	108	Good	Good	44	Good	218	Good	Good
15	Good		-	Bad	45	Good	219	Good	Good
16	Good	148	Good	Poor	46	Good	220	Poor	Poor
17	Good	155	Good	Good	47	Good	221	Good	Poor
18	Good	174	Good	Poor	48	Good	222	Good	Good
19	Good	184	Good	Good	49	Good	223	Good	Good
20	Good	193	Good	Good	50	Good	224	Good	Good
21	Good	194	Good	Good	51	Good	225	Good	Good
22	Good	195	Good	Good	52	Good	226	Poor	Poor
23	Good	196	Good	Good	53	Good	227	Poor	Poor
24	Good	197	Good	Good	54	Good	228	Good	Good
25	Good	198	Good	Good	55	Good	229	Good	Poor
26	Good	199	Good	Good					
27	Good	200	Good	Good					
28	Good	201	Good	Good					
29	Good	202	Good	Good					
30	Good	203	Good	Good					

6. DATA PRESENTATION

6.1 XBT

Profiles of temperature versus pressure calculated from the XBT data (2 dbar averages) are presented in Appendix C. Drops for which no data are presented are listed in Table 5 with explanatory comments. All data that were not obviously bad are included in the appendix. Some data in Appendix C may be of questionable quality. At this preliminary stage of the analysis, however, we do not wish to throw out data that we may be able to correct at a later time.

Table V. XBT drops for which there are no temperature profiles.

XBT	Comment
45	On backup tape only; needs to be played back
53	No file created
54	Bad
55	On backup tape only; needs to be played back
56	Bad
57	Off scale
59	Bad
67	Bad
83	Off scale
87	Off scale
102	On backup tape only; needs to be played back
141	Off scale
150	Bad
182	Bad
183	Bad
205	Bad
209	Bad
214	Bad
215	Off scale

6.2 XSV

Profiles of sound speed versus pressure calculated from the XSV data (2 dbar averages) are presented in Appendix D. Profiles are shown for all good XSV drops. The same depth correction was applied to all type 02 XSVs included in the appendix before the conversion to pressure was made. Drops for which no data are presented are listed in Table 6 with appropriate comments.

Table VI. XSV drops for which there are no sound velocity profiles.

XSV	Comment
1	Misaligned
2	Misaligned
3	Misaligned
4	Misaligned
6	Misaligned
7	Misaligned
10	Misaligned
32	Failed; reason unknown

6.3 Salinity

Profiles of temperature, sound speed, and computed salinity are presented in Appendix E. Profiles are shown for all drop pairs producing data. For the graphs included in Appendix E, the XSV probe depths were corrected individually, using comparisons with simultaneously dropped XBT probes as described in Section 5.1. The data have been gridded into 2 dbar bins. Salinity is averaged over 50 dbar; temperature and sound speed are averaged over 20 dbar. Salinity was determined as described in Section 5.4.

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APPENDIX A

Oceanus Cruise 202
XBT Log

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment

Test drops

1		T-6	09/04/88	17:52	33 07.92	16 01.20	LC	good
2		T-6	09/04/88	17:58	33 07.96	16 01.37	LC	good

Ampere Seamount Survey

3		T-7	09/05/88	19:00	35 15.18	12 36.79	LC	good
4		T-7	09/05/88	19:30	35 19.28	12 34.94	LC	good
5		T-7	09/05/88	20:00	35 19.44	12 42.45	LC	good
6		T-7	09/05/88	20:27	35 19.62	12 48.79	LC	good
7		T-7	09/05/88	20:58	35 20.06	12 56.17	LC	good
8		T-7	09/05/88	21:28	35 20.29	13 03.28	LC	good
9		T-7	09/05/88	22:02	35 20.17	13 10.86	LC	good
10		T-7	09/05/88	22:30	35 15.33	13 11.41	LC	good
11		T-7	09/05/88	22:59	35 10.42	13 12.32	LC	good
12		T-7	09/05/88	23:29	35 04.98	13 13.05	LC	good
13		T-7	09/06/88	00:00	34 58.87	13 12.91	LC	good
14		T-7	09/06/88	00:29	34 53.40	13 11.90	LC	good
15		T-7	09/06/88	01:04	34 47.66	13 10.66	OM	good
16		T-7	09/06/88	01:31	34 47.17	13 04.28	LC	good
17		T-7	09/06/88	01:59	34 46.15	12 56.96	LC	good
18		T-7	09/06/88	02:29	34 46.55	12 50.25	LC	good
19		T-7	09/06/88	03:00	34 46.53	12 43.22	LC	good
20		T-7	09/06/88	03:30	34 46.57	12 36.54	LC	good
21		T-7	09/06/88	03:59	34 48.85	12 32.98	LC	bad below 350m
22		T-7	09/06/88	04:10	34 50.91	12 32.94	LC	good
23		T-7	09/06/88	04:29	34 54.42	12 32.68	LC	good
24		T-7	09/06/88	05:00	35 00.18	12 32.32	LC	good
25		T-7	09/06/88	05:30	35 05.32	12 31.76	LC	good
26		T-7	09/06/88	06:00	35 11.40	12 32.60	LC	good
27		T-7	09/06/88	06:30	35 17.30	12 33.10	LC	good

Cape St. Vincent Region

(line 1)

28		T-5	09/11/88	02:30	36 00.46	8 00.22	LC	hit bottom 1460m
29		T-5	09/11/88	03:00	36 05.33	8 00.74	LC	good
30		T-5	09/11/88	03:30	36 09.99	8 00.69	LC	bad below 175m
31		T-5	09/11/88	03:36	36 10.55	8 00.74	LC	hit bottom 1440m

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
32		T-5	09/11/88	03:59	36 14.14	8 00.75	LC	hit bottom 1350m
33		T-5	09/11/88	04:29	36 19.06	8 00.80	LC	hit bottom 1250m
34		T-5	09/11/88	05:02	36 24.26	8 00.54	LC	hit bottom 1150m
35		T-5	09/11/88	05:29	36 28.49	8 00.17	LC	hit bottom 795m
36		T-5	09/11/88	05:59	36 33.72	7 59.94	LC	hit bottom 775m
37		T-7	09/11/88	06:29	36 39.02	7 59.86	LC	good
38		T-7	09/11/88	06:59	36 44.33	7 59.98	LC	hit bottom 700m
39		T-6	09/11/88	07:29	36 49.58	8 00.10	LC	hit bottom 400m
40		T-6	09/11/88	07:59	36 55.39	8 00.96	LC	hit bottom 80m

(line 2)

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
41		T-6	09/11/88	08:46	36 55.80	8 13.01	LC	hit bottom at 50m
42		T-7	09/11/88	09:53	36 42.08	8 13.85	LC	hit bottom at 690m
43		T-5	09/11/88	10:17	36 37.25	8 13.79	LC	hit bottom at 840m
44		T-5	09/11/88	10:42	36 33.00	8 13.26	LC	hit bottom at 1110m
45		T-5	09/11/88	11:11	36 28.00	8 12.68	LC	needs playback
46		T-5	09/11/88	11:29	36 24.47	8 12.38	LC	hit bottom 1150m
47		T-5	09/11/88	12:03	36 17.97	8 12.62	LC	good
48		T-5	09/11/88	12:41	36 11.19	8 13.44	LC	wire broke 1125m
49		T-5	09/11/88	12:47	36 10.02	8 13.47	LC	wire broke 1125m
50		T-5	09/11/88	13:05	36 06.63	8 12.69	LC	noisy
51		T-5	09/11/88	13:11	36 06.11	8 12.58	LC	good
52		T-5	09/11/88	13:30	36 03.02	8 12.74	LC	? below 1100m

(line 3)

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
53		T-5	09/11/88	14:29	36 00.20	8 25.09	LC	no file created
54		T-5	09/11/88	14:33	36 00.61	8 25.08	LC	bad
55		T-5	09/11/88	15:04	36 05.87	8 24.89	LC	needs playback
56		T-5	09/11/88	15:35	36 11.05	8 24.73	LC	bad
57		T-5	09/11/88	15:42	36 11.72	8 24.74	LC	bad
58		T-5	09/11/88	16:17	36 16.47	8 24.62	LC	hit bottom 1590m
59		T-5	09/11/88	16:52	36 21.94	8 24.35	LC	bad
60		T-7	09/11/88	16:59	36 22.68	8 24.28	LC	good
61		T-5	09/11/88	17:24	36 27.20	8 24.02	LC	hit bottom 1440m
62		T-5	09/11/88	18:00	36 34.06	8 23.71	LC	hit bottom 1300m
63		T-7	09/11/88	18:34	36 40.42	8 24.19	LC	hit bottom at 730m
64		T-7	09/11/88	18:58	36 44.53	8 25.66	LC	good
65		T-6	09/11/88	19:20	36 48.36	8 26.41	LC	hit bottom at 310m

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				(line 4)				
66		T-6	09/11/88	20:13	36 50.32	8 36.96	LC	hit bottom at 250m
67		T-5	09/12/88	11:32	36 05.78	8 37.61	LC	bad
68		T-5	09/12/88	11:35	36 05.57	8 37.62	LC	bad below 300m
69		T-5	09/12/88	13:30	35 59.86	8 37.57	LC	good
70		T-5	09/12/88	15:35	35 54.57	8 37.69	LC	good
				(line 5)				
71		T-5	09/12/88	16:02	35 55.07	8 42.29	LC	good
72		T-5	09/12/88	16:36	36 00.51	8 41.49	LC	good
73		T-5	09/12/88	17:04	36 05.35	8 41.25	LC	good
74		T-5	09/12/88	17:31	36 10.13	8 41.51	LC	good
75		T-5	09/12/88	18:03	36 16.10	8 41.96	LC	good
76		T-5	09/12/88	18:31	36 21.07	8 42.05	LC	good
77		T-5	09/12/88	18:56	36 25.33	8 42.01	LC	T jump at 250m
78		T-5	09/12/88	19:27	36 30.46	8 41.72	LC	hit bottom 1290m
79		T-5	09/12/88	19:32	36 30.93	8 41.67	LC	hit bottom 1260m
80		T-5	09/12/88	20:00	36 35.20	8 41.72	LC	hit bottom 1020m
81		T-7	09/12/88	20:26	36 39.73	8 42.51	LC	bad below 470m
82		T-7	09/12/88	21:06	36 45.58	8 44.22	LC	hit bottom 650m
				(line 6)				
83		T-7	09/12/88	22:17	36 45.04	8 50.58	LC	bad
84		T-7	09/12/88	22:19	36 44.82	8 50.66	LC	hit bottom 650m
85		T-5	09/12/88	22:49	36 40.50	8 51.08	LC	hit bottom 740m
86		T-5	09/12/88	23:25	36 34.63	8 50.64	LC	hit bottom 1200m
87		T-5	09/12/88	23:52	36 30.55	8 49.79	LC	bad
88		T-5	09/12/88	23:56	36 30.20	8 49.70	LC	good
89		T-5	09/13/88	00:24	36 25.79	8 48.86	LC	good
90		T-5	09/13/88	01:02	36 20.07	8 48.04	LC	good
91		T-5	09/13/88	01:33	36 14.90	8 48.95	LC	good
92		T-5	09/13/88	02:06	36 09.60	8 49.85	LC	good
93		T-5	09/13/88	02:38	36 04.44	8 50.42	LC	good
94		T-5	09/13/88	03:08	35 59.56	8 49.74	LC	good

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				(line 7)				
95		T-5	09/13/88	03:43	36 00.11	8 55.78	LC	good
96		T-5	09/13/88	04:13	36 04.89	8 55.76	LC	good
97		T-5	09/13/88	04:43	36 09.65	8 55.84	LC	good
98		T-5	09/13/88	05:15	36 14.86	8 55.96	LC	good
99		T-5	09/13/88	05:45	36 19.77	8 55.89	LC	good
100		T-5	09/13/88	06:17	36 25.02	8 55.62	LC	good
101		T-5	09/13/88	06:47	36 29.61	8 55.07	LC	good
102		T-5	09/13/88	07:18	36 34.21	8 54.37	LC	needs playback
103		T-5	09/13/88	08:12	36 39.64	8 54.79	LC	hit bottom at 750m
104		T-7	09/13/88	08:42	36 45.03	8 55.97	LC	hit bottom at 675m
				(line 8)				
105		T-5	09/13/88	12:54	36 33.78	9 01.30	LC	bad below 1500m
106	178742	T-5	09/13/88	16:17	36 24.64	9 02.51	LC	good
107	200982	T-5	09/13/88	16:53	36 19.81	9 02.93	LC	good
108	200981	T-5	09/13/88	21:03	36 02.81	9 01.14	LC	good
				(lines 9 thru 12)				
109	200980	T-5	09/13/88	23:25	35 59.96	9 08.69	LC	good
110	200985	T-5	09/14/88	00:24	36 09.87	9 09.23	LC	good
111	200984	T-5	09/14/88	00:59	36 09.91	9 16.73	LC	good
112	200983	T-5	09/14/88	01:29	36 10.28	9 23.24	LC	good
113	200986	T-5	09/14/88	02:00	36 10.66	9 29.88	LC	good
114	200988	T-5	09/14/88	02:29	36 10.13	9 36.05	LC	good
115	200987	T-5	09/14/88	02:53	36 09.92	9 40.31	LC	good
116	200846	T-5	09/14/88	03:38	36 14.97	9 45.59	LC	good
117	200847	T-5	09/14/88	04:24	36 20.51	9 51.53	LC	good
118	200845	T-5	09/14/88	04:56	36 20.22	9 44.81	LC	good
119	200848	T-5	09/14/88	05:30	36 19.91	9 37.69	LC	good
120	200843	T-5	09/14/88	05:59	36 19.61	9 31.71	LC	good
121	200850	T-5	09/14/88	06:29	36 19.29	9 25.42	LC	good
122	200859	T-5	09/14/88	06:59	36 18.69	9 19.08	LC	good
123	200842	T-5	09/14/88	07:29	36 19.28	9 13.07	LC	good
124	200851	T-5	09/14/88	08:00	36 21.06	9 08.07	LC	good

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				(line 13)				
125	200854	T-5	09/14/88	09:06	36 31.05	9 08.63	LC	good
126	200855	T-5	09/14/88	09:45	36 30.83	9 14.82	LC	bad below 1600m
127	200856	T-5	09/14/88	10:15	36 30.65	9 20.34	LC	good
128	200889	T-5	09/14/88	10:23	36 30.58	9 21.23	LC	T offset
129	200890	T-5	09/14/88	10:51	36 30.46	9 26.68	LC	good
130	200891	T-5	09/14/88	11:21	36 30.38	9 32.69	LC	good
131	200892	T-5	09/14/88	11:56	36 30.26	9 39.61	LC	good
132	200881	T-5	09/14/88	12:33	36 30.22	9 47.16	LC	good
133	200882	T-5	09/14/88	13:00	36 30.35	9 52.31	LC	good
134	200883	T-5	09/14/88	13:31	36 30.47	9 58.33	LC	good
135	200884	T-5	09/14/88	14:02	36 30.48	10 04.45	LC	good
136	200885	T-5	09/14/88	14:38	36 30.71	10 10.84	LC	good
				(line 14)				
137	200886	T-5	09/14/88	15:43	36 40.78	10 09.73	LC	good
138	200887	T-5	09/14/88	16:02	36 40.55	10 05.98	LC	good
139	200888	T-5	09/14/88	16:30	36 40.37	10 00.31	LC	good
140	200913	T-5	09/14/88	16:58	36 39.46	9 54.49	LC	good
141		T-5	09/14/88	17:44	36 39.16	9 44.49	LC	bad
142	200914	T-5	09/14/88	17:45	36 39.16	9 44.38	LC	T offset
143	200915	T-5	09/14/88	18:21	36 39.51	9 38.90	LC	good
144	200916	T-5	09/14/88	18:47	36 39.26	9 33.09	LC	good
145	200905	T-5	09/14/88	19:18	36 39.03	9 26.71	LC	good
146	200912	T-5	09/14/88	19:47	36 38.66	9 20.40	LC	hit botoom 1500m
147	200911	T-5	09/14/88	20:19	36 38.27	9 14.89	LC	hit botoom 1600m
148	200910	T-5	09/14/88	21:01	36 40.31	9 06.74	LC	hit bottom 1000m
				(line 15)				
149	200906	T-5	09/14/88	22:01	36 49.92	9 07.97	LC	hit bottom 600m
150	640596	T-7	09/14/88	22:42	36 49.29	9 16.43	LC	bad
151	640591	T-7	09/14/88	22:46	36 49.25	9 16.91	LC	good
152	200907	T-5	09/14/88	23:16	36 49.16	9 22.99	LC	hit bottom 850m
153	200908	T-5	09/14/88	23:43	36 49.31	9 28.51	LC	hit bottom 1275m
154	200909	T-5	09/15/88	00:15	36 49.80	9 34.87	LC	good
155	200413	T-5	09/15/88	00:50	36 50.33	9 41.65	LC	good
156	200414	T-5	09/15/88	01:19	36 50.77	9 47.27	LC	good
157	200415	T-5	09/15/88	01:49	36 50.91	9 53.37	LC	good

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				(line 15), cont.				
158	200416	T-5	09/15/88	02:23	36 50.73	10 00.08	LC	good
159	200417	T-5	09/15/88	02:49	36 50.50	10 05.15	LC	good
160	200418	T-5	09/15/88	03:22	36 50.61	10 11.18	LC	good
				(line 16)				
161	200419	T-5	09/15/88	04:23	37 00.42	10 11.22	LC	good
162	200420	T-5	09/15/88	04:50	37 00.30	10 06.13	LC	good
163	200421	T-5	09/15/88	05:17	37 00.34	10 00.91	LC	good
164	200422	T-5	09/15/88	06:00	37 00.38	9 52.16	LC	bad below 150m
165	200423	T-5	09/15/88	06:04	37 00.37	9 51.65	LC	good
166	200424	T-5	09/15/88	06:32	37 00.21	9 45.89	LC	T offset
167	200857	T-5	09/15/88	06:59	37 00.02	9 40.36	LC	good
168	200858	T-5	09/15/88	07:29	36 59.85	9 33.92	LC	hit bottom 1525m
169	200859	T-5	09/15/88	08:01	36 59.83	9 26.78	LC	hit bottom 1525m
170	200860	T-5	09/15/88	08:29	36 59.77	9 20.41	LC	good
171	200861	T-5	09/15/88	09:03	36 59.63	9 13.96	LC	hit bottom 1000m
172	640590	T-7	09/15/88	09:27	37 00.17	9 09.19	LC	hit bottom 600m
				(line 17)				
173	200863	T-5	09/15/88	13:53	37 10.37	9 27.17	LC	hit bottom 1270m
174	200862	T-5	09/15/88	21:22	37 14.42	9 51.45	LC	hit bottom 1550m
				(line 18)				
175	200864	T-5	09/16/88	10:17	37 13.68	10 27.94	LC	good
176	200866	T-5	09/16/88	10:50	37 18.56	10 25.32	LC	good
177	200868	T-5	09/16/88	11:22	37 22.97	10 22.92	LC	good
178	200867	T-5	09/16/88	11:51	37 26.99	10 20.75	LC	good
179	200865	T-5	09/16/88	12:23	37 31.71	10 18.87	LC	bad below 1250m
180	200869	T-5	09/16/88	12:55	37 36.85	10 17.43	LC	bad below 1350m
181	200871	T-5	09/16/88	13:16	37 40.29	10 16.69	LC	good
182	200872	T-5	09/16/88	13:53	37 46.15	10 14.99	LC	bad
183	200873	T-5	09/16/88	13:57	37 46.51	10 14.91	LC	bad

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				(line 19)				
184	640592	T-7	09/16/88	21:19	37 51.68	9 29.11	LC	good
				To Meddy and initial search				
185	200876	T-5	09/17/88	04:13	36 39.84	9 19.84	LC	bad below 1300m
186	178744	T-5	09/17/88	05:08	36 30.37	9 18.31	LC	good
187	200875	T-5	09/17/88	06:03	36 20.93	9 14.81	LC	good
188	200877	T-5	09/17/88	06:39	36 16.04	9 11.03	LC	good
189	200878	T-5	09/17/88	07:09	36 12.77	9 06.71	LC	good
190	200879	T-5	09/17/88	07:41	36 09.29	9 02.14	LC	good
191	200880	T-5	09/17/88	08:09	36 09.70	9 06.71	LC	good
192	200893	T-5	09/17/88	08:42	36 10.62	9 13.20	LC	good
193	200894	T-5	09/17/88	09:25	36 05.29	9 13.82	LC	good
194	200895	T-5	09/17/88	09:57	36 00.54	9 14.72	LC	good
195	200896	T-5	09/17/88	10:34	36 00.09	9 09.21	LC	good
196	200897	T-5	09/17/88	11:15	35 59.51	9 02.02	LC	good
197	200901	T-5	09/17/88	11:56	36 04.59	9 01.86	LC	good
198	200902	T-5	09/17/88	12:37	36 05.58	9 08.82	LC	good
199	200903	T-5	09/17/88	13:35	36 04.53	9 20.42	LC	good
200	200898	T-5	09/17/88	16:59	36 04.37	9 10.70	LC	good
				Meddy Survey (leg 1)				
201	200904	T-5	09/17/88	21:33	35 57.30	9 12.46	LC	good
202	200900	T-5	09/17/88	21:52	35 59.00	9 12.16	LC	good
203	200899	T-5	09/17/88	22:11	36 00.68	9 11.79	LC	good
204	201003	T-5	09/17/88	22:32	36 02.52	9 11.44	LC	good
205	201002	T-5	09/17/88	22:52	36 04.26	9 11.04	LC	bad
206	201009	T-5	09/17/88	23:10	36 05.85	9 10.75	LC	good
207	201006	T-5	09/17/88	23:31	36 07.60	9 10.42	LC	bad
208	201005	T-5	09/17/88	23:49	36 09.18	9 10.63	LC	good
209	201001	T-5	09/18/88	00:10	36 10.93	9 11.01	LC	bad
210	201004	T-5	09/18/88	00:30	36 12.58	9 11.52	LC	good

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				Meddy Survey (leg 2)				
211	201007	T-5	09/18/88	02:52	36 08.61	9 05.86	LC	good
212	201008	T-5	09/18/88	03:22	36 06.61	9 07.86	LC	good
213	201010	T-5	09/18/88	03:44	36 05.59	9 10.23	LC	good
214	201011	T-5	09/18/88	04:04	36 04.71	9 12.34	LC	bad
215	201012	T-5	09/18/88	04:08	36 04.53	9 12.75	LC	bad
216	200821	T-5	09/18/88	04:25	36 03.81	9 14.57	LC	good
217	178745	T-5	09/18/88	04:46	36 02.83	9 16.76	LC	good
218	200823	T-5	09/18/88	05:35	36 01.54	9 18.91	LC	good
219	200824	T-5	09/18/88	05:56	36 00.58	9 21.24	LC	good
220	200825	T-5	09/18/88	06:18	35 59.63	9 23.68	LC	noisy
				Meddy Survey (leg 3)				
221	200826	T-5	09/18/88	07:50	36 09.80	9 20.24	LC	good
222	200827	T-5	09/18/88	08:09	36 08.77	9 18.45	LC	good
223	200828	T-5	09/18/88	08:32	36 07.57	9 16.25	LC	good
224	200829	T-5	09/18/88	08:53	36 06.44	9 14.35	LC	good
225	200830	T-5	09/18/88	09:12	36 05.42	9 12.71	LC	good
226	200831	T-5	09/18/88	09:43	36 03.90	9 09.97	LC	bad below 300m
227	200832	T-5	09/18/88	10:08	36 02.74	9 07.88	LC	bad below 400m
228	201013	T-5	09/18/88	10:31	36 01.69	9 06.06	LC	good
229	201014	T-5	09/18/88	10:57	36 00.58	9 04.16	LC	good

APPENDIX B

Oceanus Cruise 202
XSV Log

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				Cape St. Vincent Region				
				(line 2)				
1		XSV-02	09/11/88	10:42	36 33.00	8 13.26	LC	failed
2		XSV-02	09/11/88	11:11	36 28.00	8 12.68	LC	failed
3		XSV-02	09/11/88	11:29	36 24.47	8 12.38	LC	failed
				(line 3)				
4		XSV-02	09/11/88	15:35	36 11.05	8 24.73	LC	failed
5		XSV-02	09/11/88	16:17	36 16.47	8 24.62	LC	good
6		XSV-02	09/11/88	16:52	36 21.94	8 24.35	LC	failed
7		XSV-02	09/11/88	18:00	36 34.06	8 23.71	LC	failed
				(line 4)				
8		XSV-03	09/11/88	21:14	36 45.45	8 37.47	LC	good
9		XSV-03	09/11/88	22:40	36 39.40	8 38.37	LC	good
				(line 8)				
10		XSV-02	09/13/88	12:54	36 33.78	9 01.30	LC	failed
11		XSV-02	09/13/88	12:55	36 33.68	9 01.29	LC	good
12		XSV-02	09/13/88	16:16	36 24.76	9 02.53	LC	Note 1, good
13		XSV-02	09/13/88	16:53	36 19.81	9 02.93	LC	good
14	013619	XSV-02	09/13/88	21:03	36 02.81	9 01.14	LC	good
				(line 13)				
15	013629	XSV-02	09/14/88	09:16	36 30.98	9 09.70	LC	good
				(line 14)				
16	013626	XSV-02	09/14/88	21:01	36 40.31	9 06.74	LC	good
				(line 15)				
17	013666	XSV-02	09/15/88	00:50	36 50.33	9 41.65	LC	good

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				(line 17)				
18	01362	XSV-02	09/15/88	21:22	37 14.42	9 51.45	LC	good
				(line 19)				
19	011177	XSV-03	09/16/88	21:19	37 51.68	9 29.11	LC	good
				To Meddy and initial survey				
20	013630	XSV-02	09/17/88	09:25	36 05.29	9 13.82	LC	Note 1, good
21	013628	XSV-02	09/17/88	09:57	36 00.54	9 14.72	LC	Note 1, good
22	013622	XSV-02	09/17/88	10:34	36 00.09	9 09.21	LC	Note 1, good
23	013627	XSV-02	09/17/88	11:15	35 59.51	9 02.02	LC	good
24	013665	XSV-02	09/17/88	11:56	36 04.59	9 01.86	LC	good
25	013623	XSV-02	09/17/88	12:37	36 05.58	9 08.82	LC	good
26	013624	XSV-02	09/17/88	13:35	36 04.53	9 20.42	LC	good
27	013664	XSV-02	09/17/88	16:59	36 04.37	9 10.70	LC	Notes 1 & 3
				Meddy Survey (leg 1)				
28	013654	XSV-02	09/17/88	21:33	35 57.30	9 12.46	LC	good
29	013643	XSV-02	09/17/88	21:52	35 59.00	9 12.16	LC	good
30	013644	XSV-02	09/17/88	22:11	36 00.68	9 11.79	LC	good
31	013651	XSV-02	09/17/88	22:32	36 02.52	9 11.44	LC	good
32	013653	XSV-02	09/17/88	22:52	36 04.26	9 11.04	LC	failed
33	013652	XSV-02	09/17/88	23:10	36 05.85	9 10.75	LC	good
34	013646	XSV-02	09/17/88	23:31	36 07.60	9 10.42	LC	good
35	013647	XSV-02	09/17/88	23:49	36 09.18	9 10.63	LC	Note 2, good
36	013645	XSV-02	09/18/88	00:10	36 10.93	9 11.01	LC	good
37	013648	XSV-02	09/18/88	00:30	36 12.58	9 11.52	LC	Note 1, good
				Meddy Survey (leg 2)				
38	013649	XSV-02	09/18/88	02:52	36 08.61	9 05.86	LC	Note 1, good
39	013650	XSV-02	09/18/88	03:22	36 06.61	9 07.86	LC	noisy
40	013640	XSV-02	09/18/88	03:44	36 05.59	9 10.23	LC	Note 1, good
41	013641	XSV-02	09/18/88	04:04	36 04.71	9 12.34	LC	good
42	013642	XSV-02	09/18/88	04:25	36 03.81	9 14.57	LC	good
43	013637	XSV-02	09/18/88	04:46	36 02.83	9 16.76	LC	Notes 1 & 4
44	013638	XSV-02	09/18/88	05:35	36 01.54	9 18.91	LC	good
45	013639	XSV-02	09/18/88	05:56	36 00.58	9 21.24	LC	Note 1, good
46	013636	XSV-02	09/18/88	06:18	35 59.63	9 23.68	LC	good

Drop #	Serial #	Type	Date	Time	Latitude	Longitude	Method	Comment
				Meddy Survey (leg 3)				
47	013635	XSV-02	09/18/88	07:50	36 09.80	9 20.24	LC	Note 1, good
48	013634	XSV-02	09/18/88	08:09	36 08.77	9 18.45	LC	Note 1, good
49	013633	XSV-02	09/18/88	08:32	36 07.57	9 16.25	LC	Note 1, good
50	013632	XSV-02	09/18/88	08:53	36 06.44	9 14.35	LC	Note 1, good
51	013631	XSV-02	09/18/88	09:12	36 05.42	9 12.71	LC	good
52	013678	XSV-02	09/18/88	09:43	36 03.90	9 09.97	LC	good
53	013677	XSV-02	09/18/88	10:08	36 02.74	9 07.88	LC	good
54	013676	XSV-02	09/18/88	10:31	36 01.69	9 06.06	LC	good
55	013673	XSV-02	09/18/88	10:57	36 00.58	9 04.16	LC	good

Note 1. Probe end misaligned/rotated to proper alignment.
Note 2. Wire wrapped around tab.
Note 3. Bad below 175 m and 750 m.
Note 4. Bad below 125 m and 175 m.

APPENDIX C

Profiles of Temperature versus Pressure

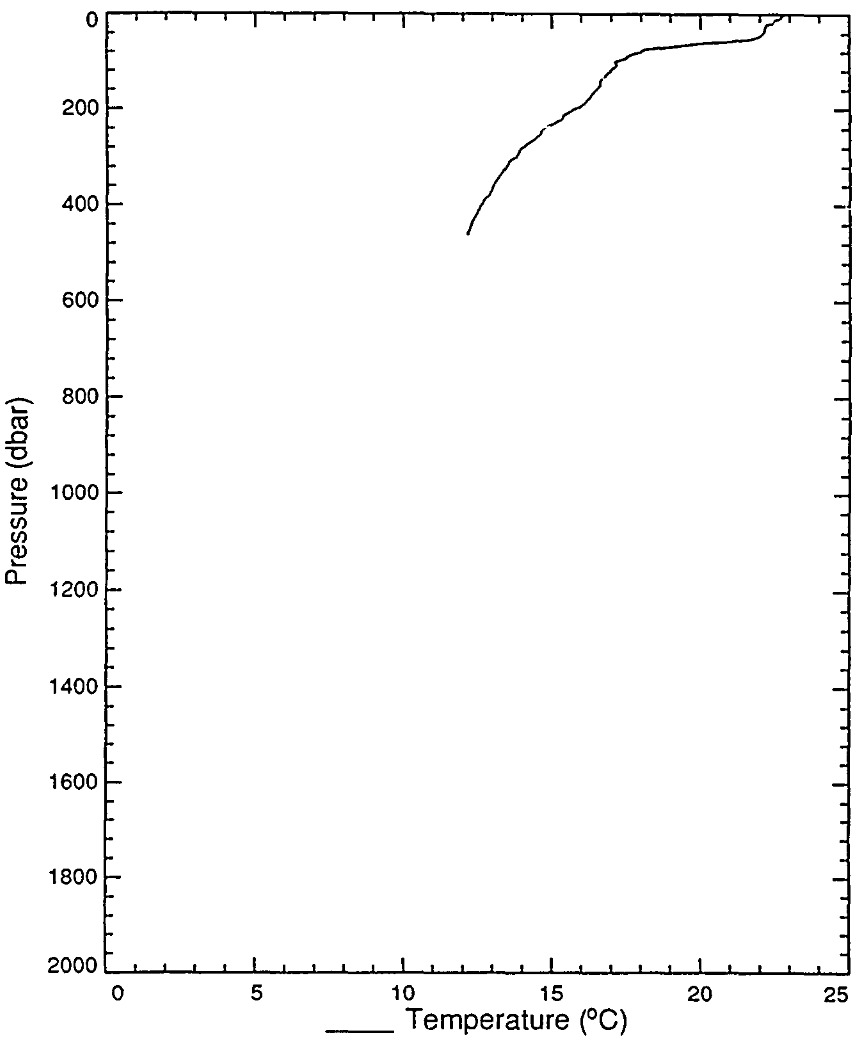
Depths were converted to pressure using the following relation between pressure and depth determined for the Cadiz data:

$$\text{ratio (pressure)} = 0.9927 - 2.55 \times 10^{-6}\ \text{pressure} + 0.0073\ \exp(-\text{pressure}/50).$$

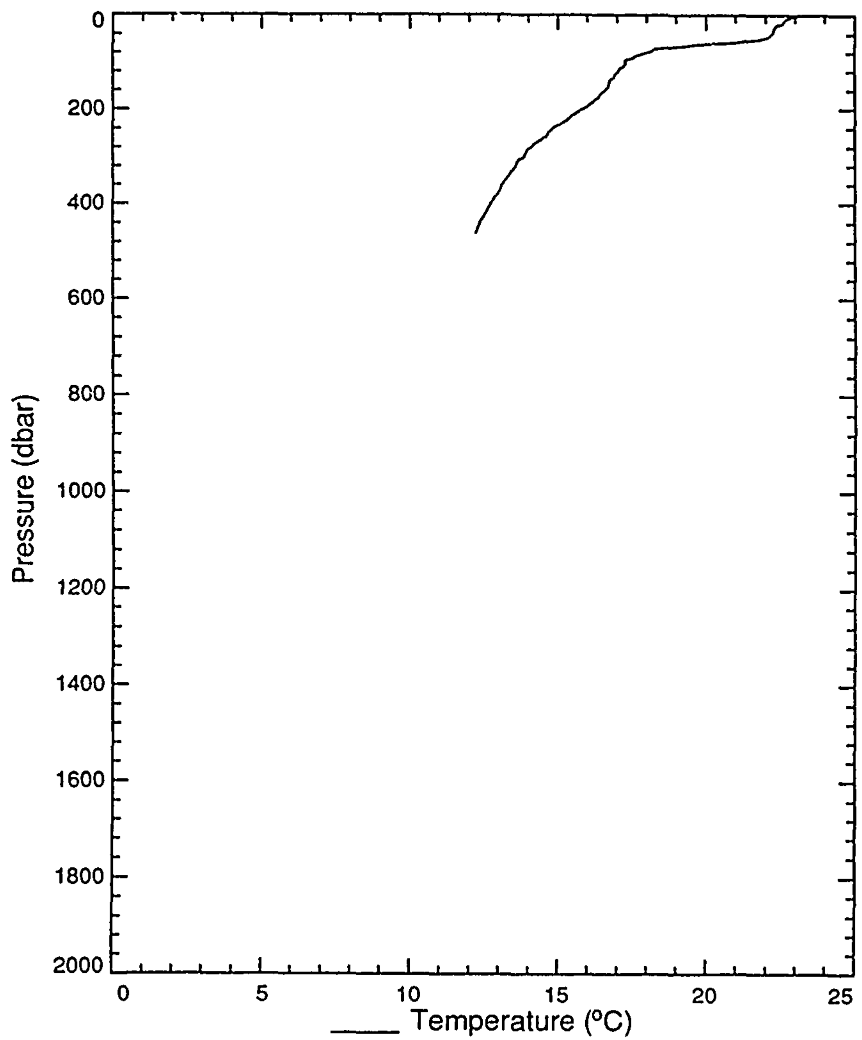
$$\text{XBT pressure} = -(\text{XBT depth}/\text{ratio})$$

For the T-5 XBTs, 0.075°C was subtracted from the temperature values. The data are gridded into 2 dbar values. The graphs have been terminated at the end of good data.

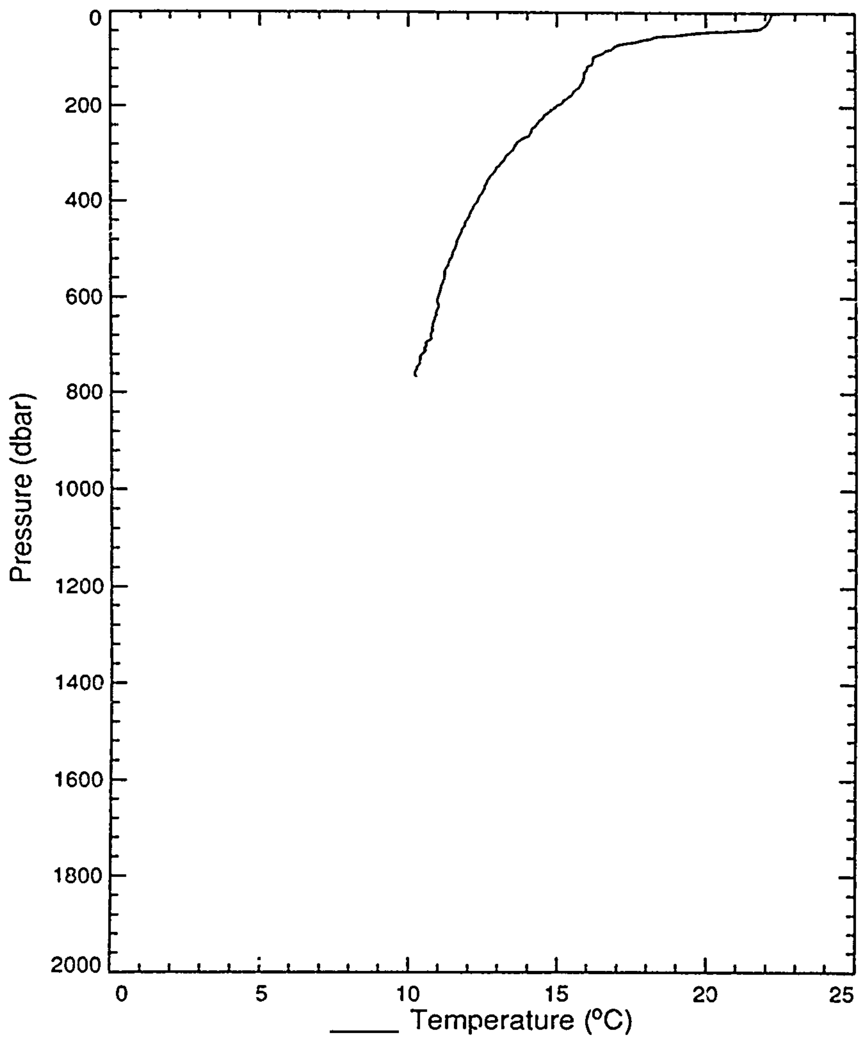
XBT 001



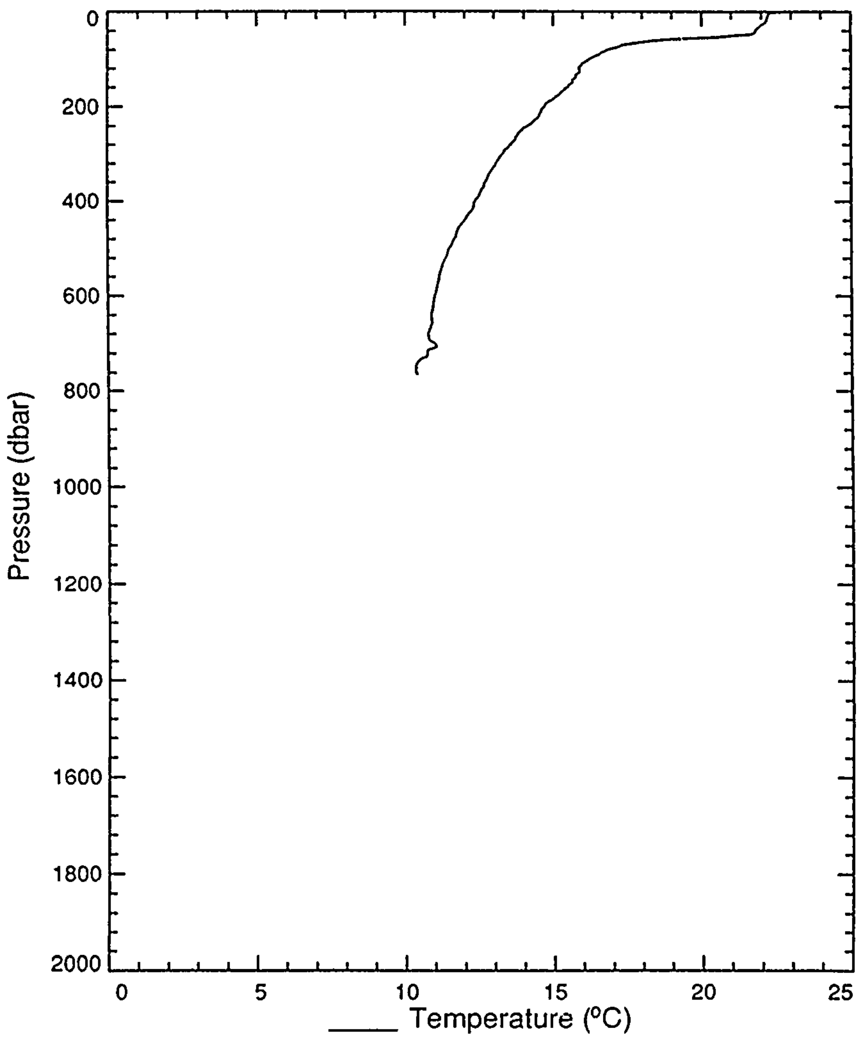
XBT 002

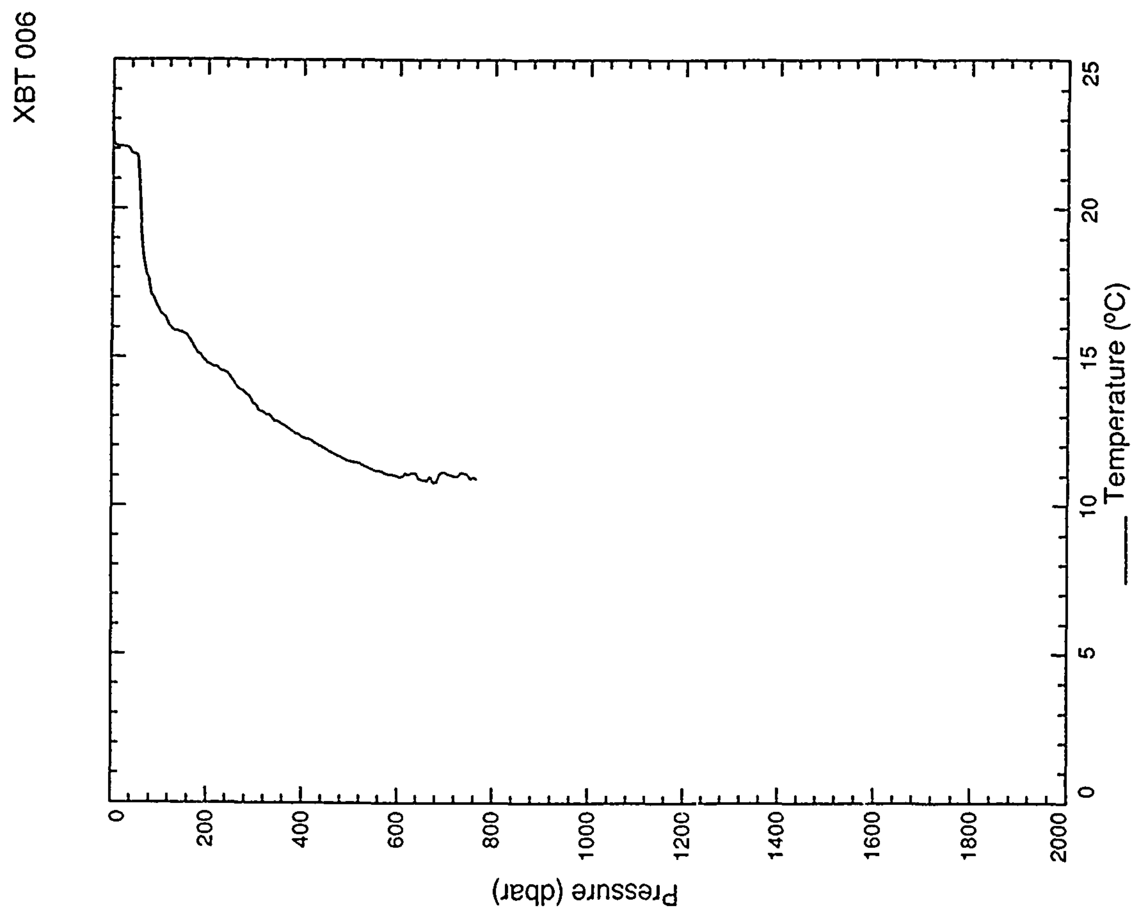


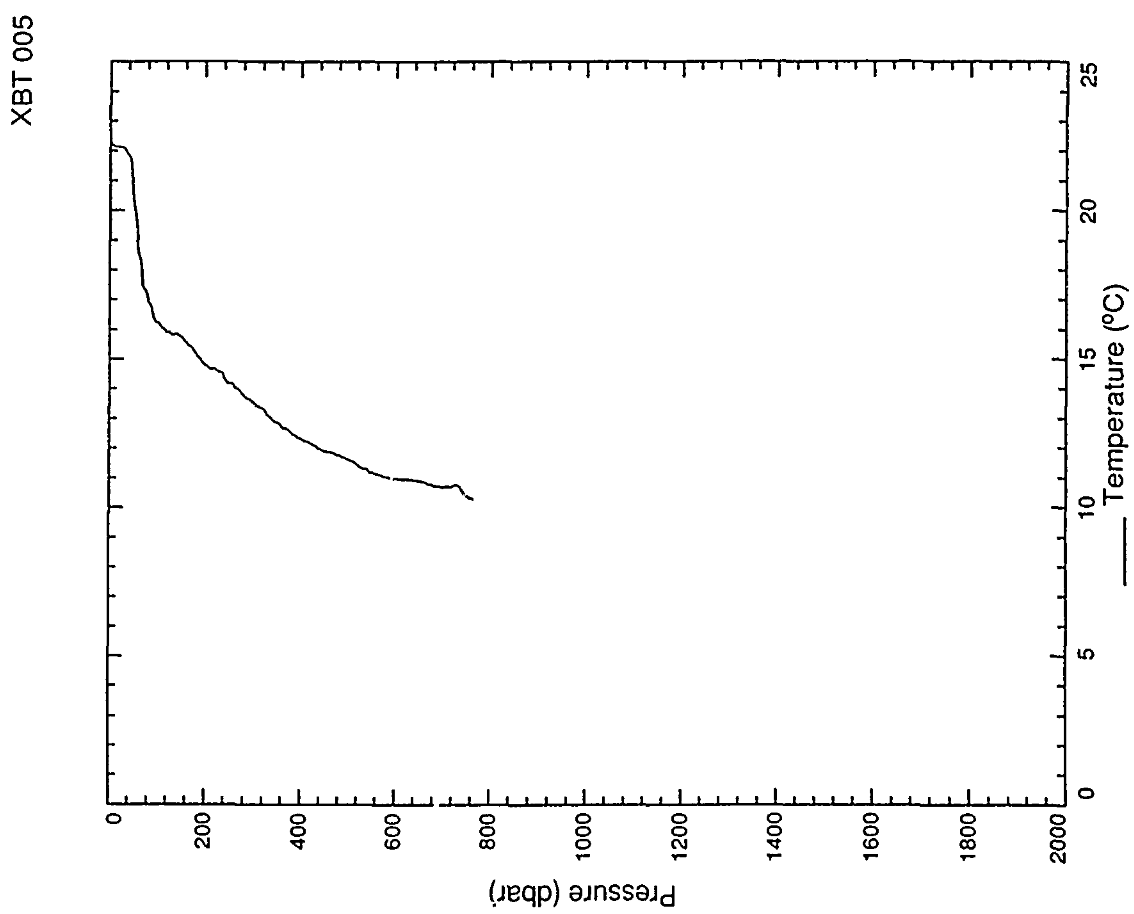
XBT 003

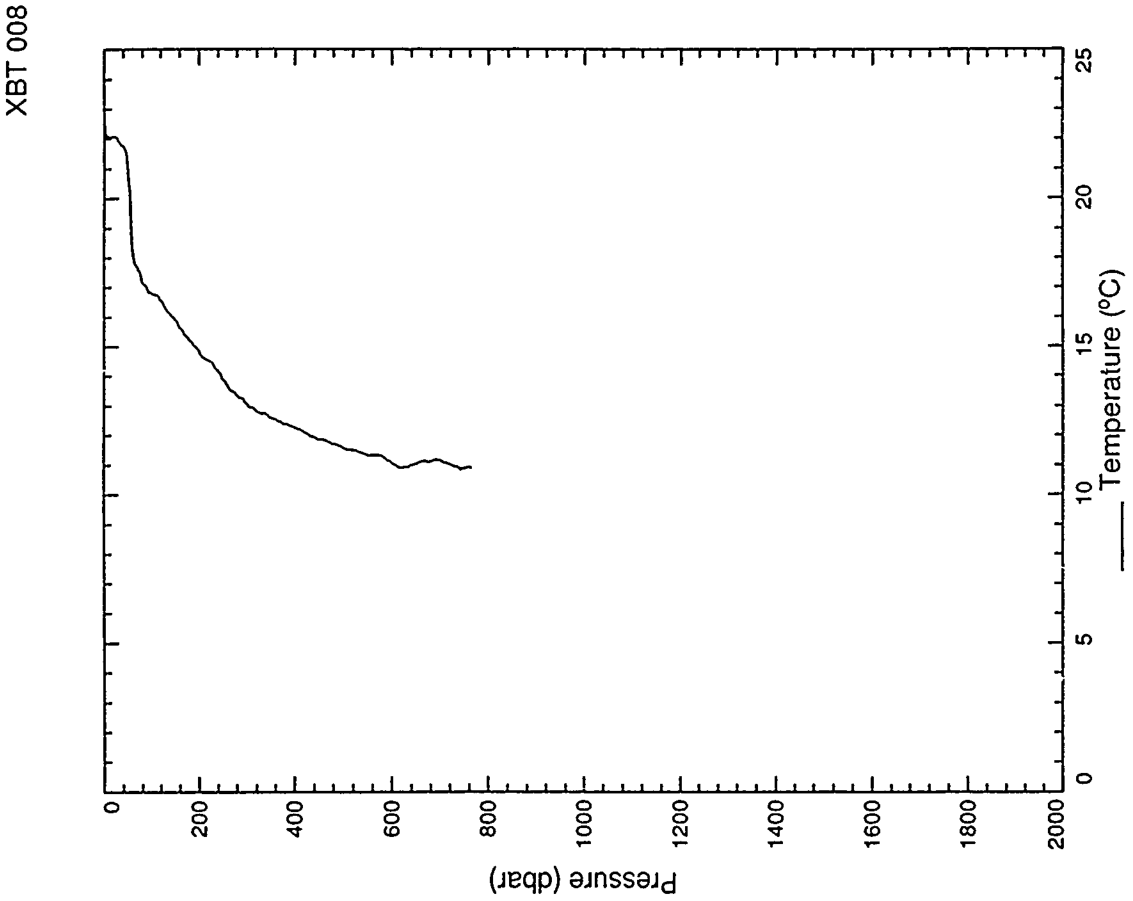


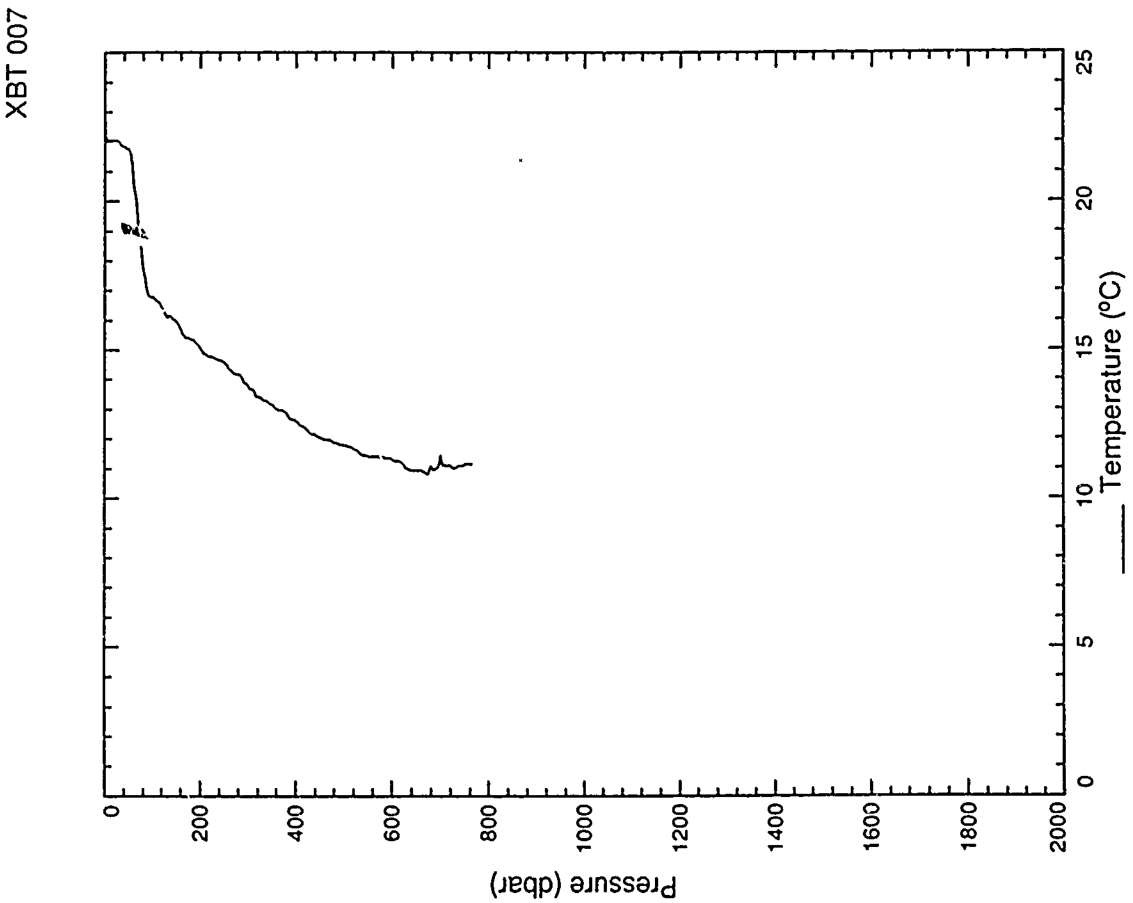
XBT 004

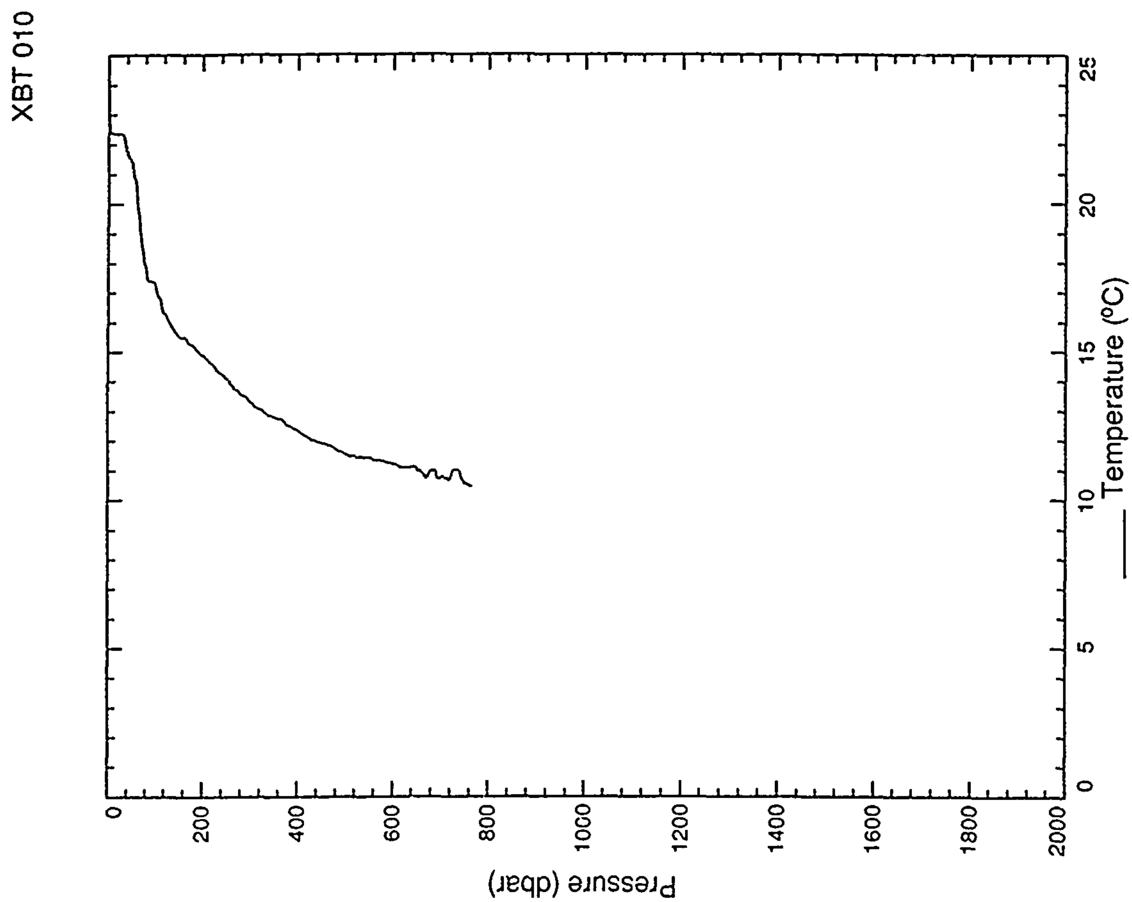


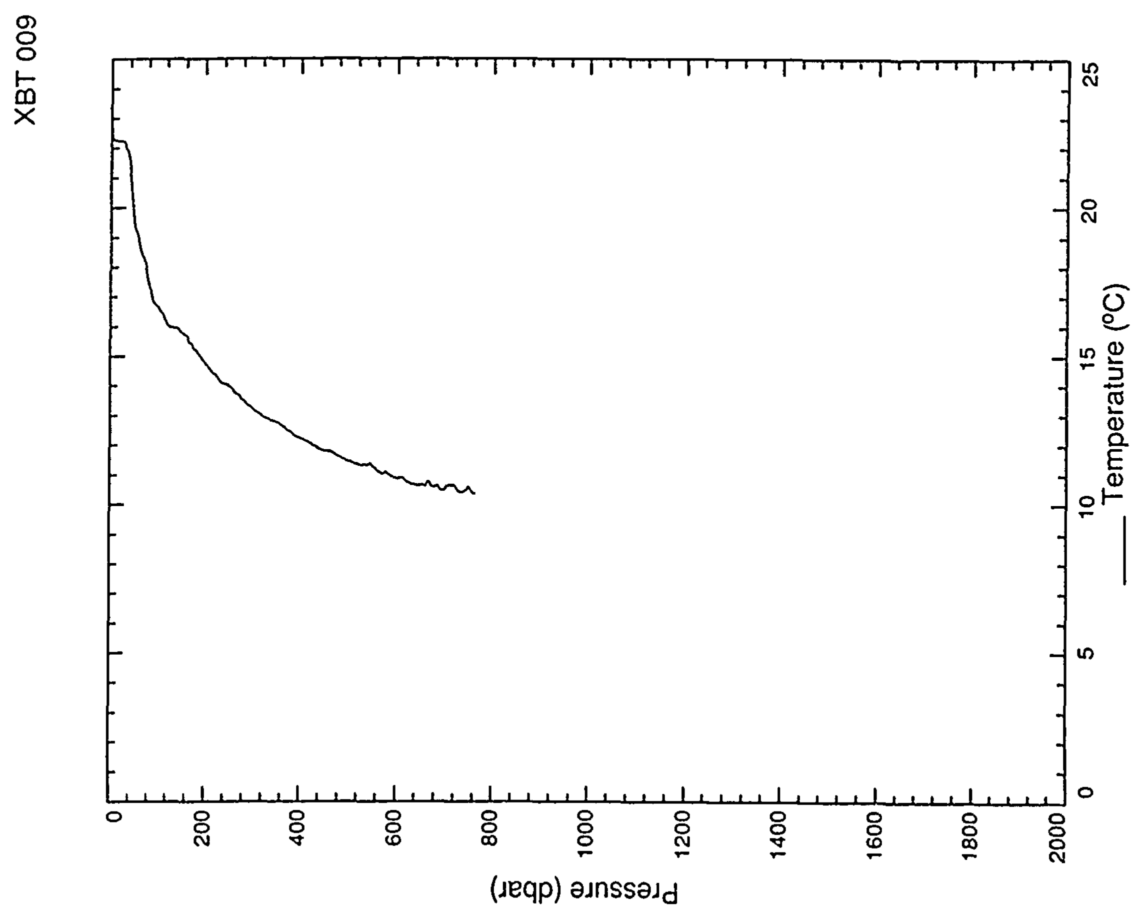

XBT 006
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (°C)

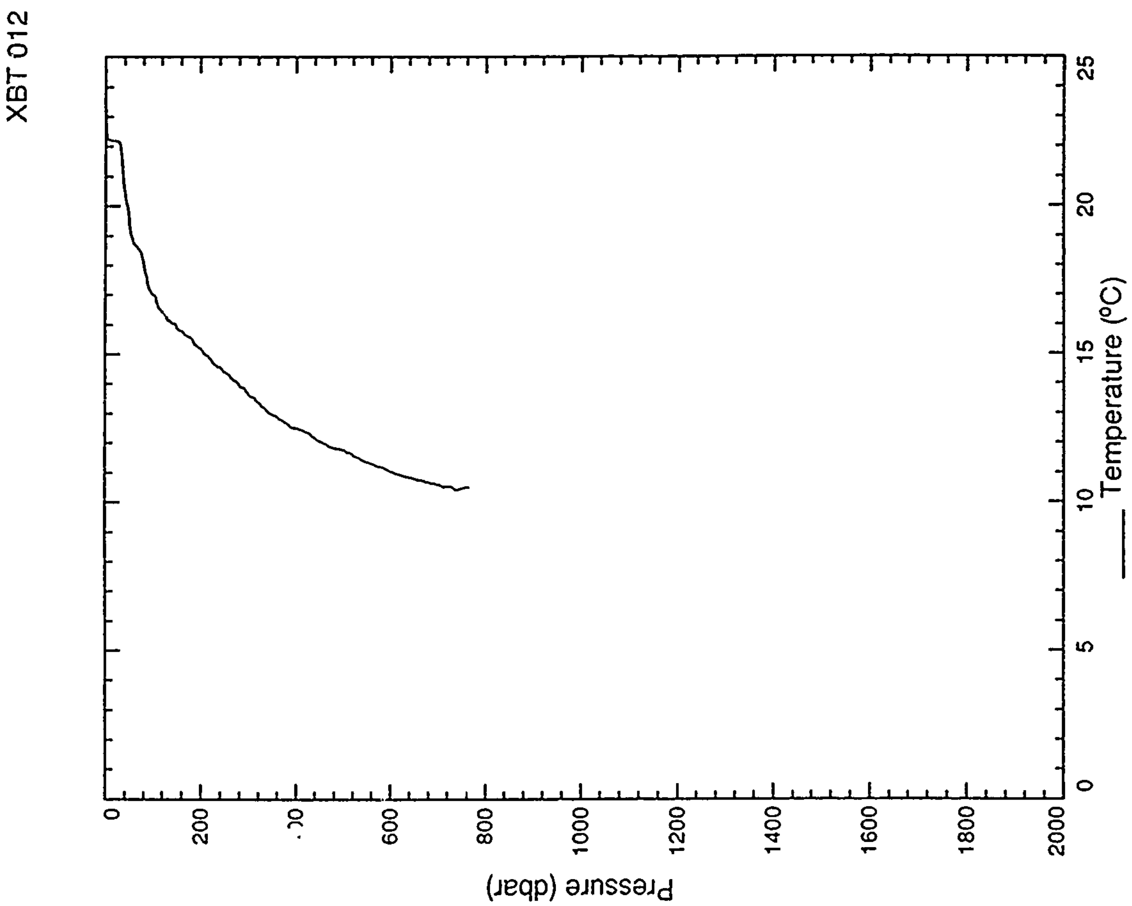

XBT 005
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (°C)

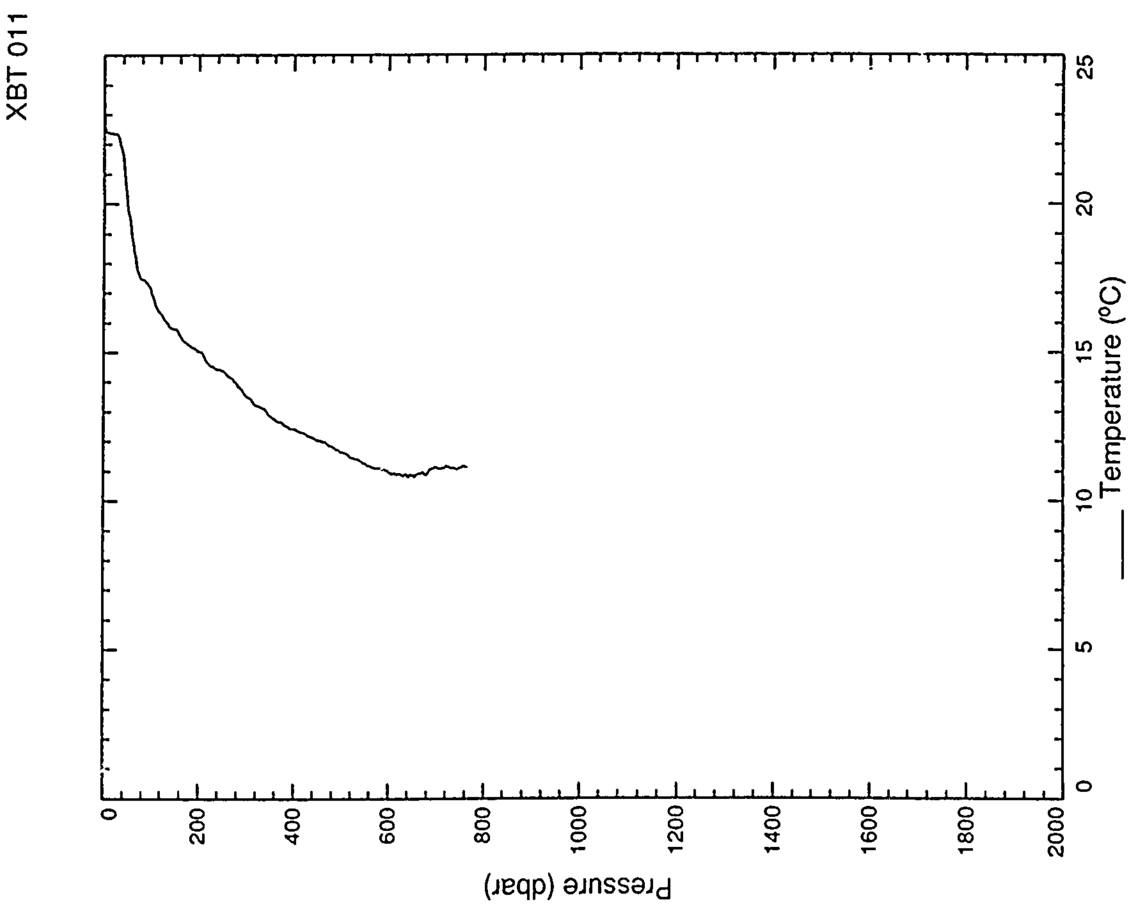

XBT 008
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

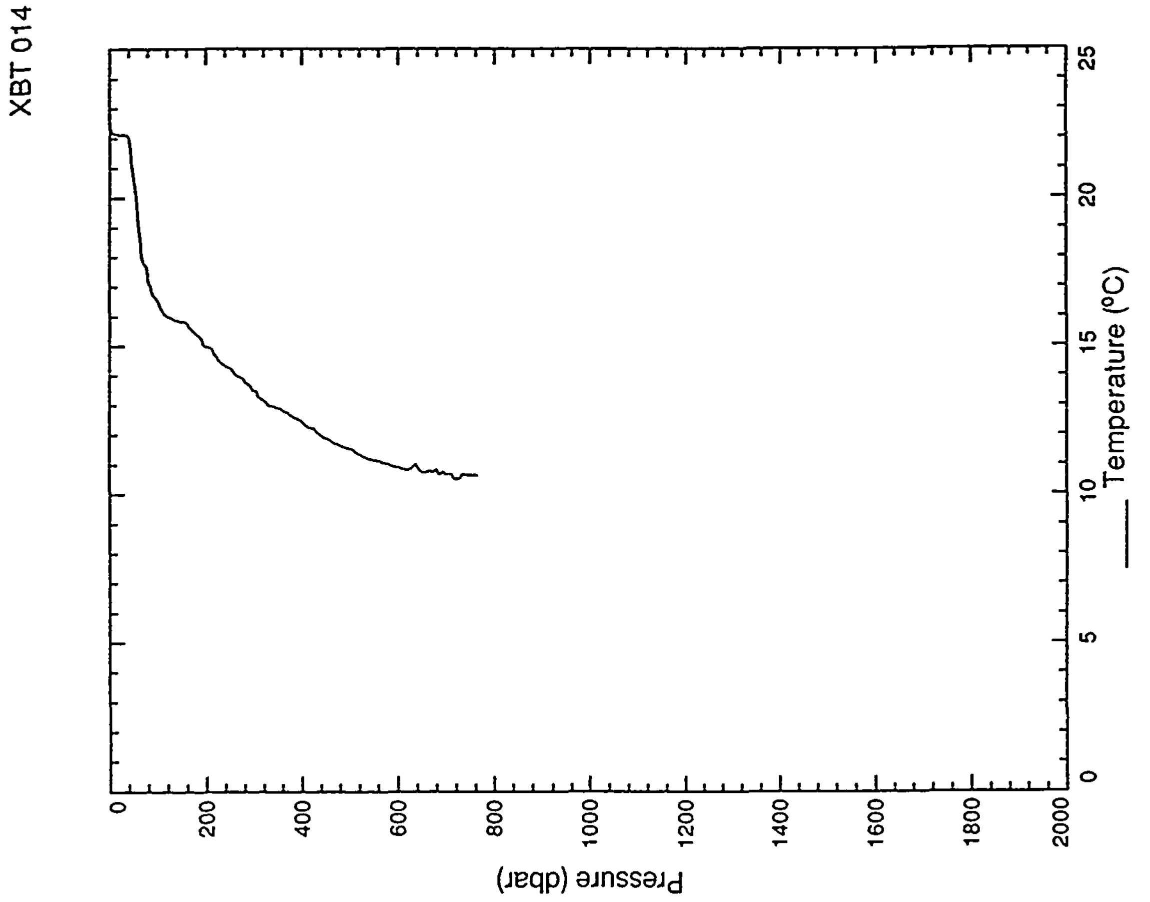

XBT 007
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

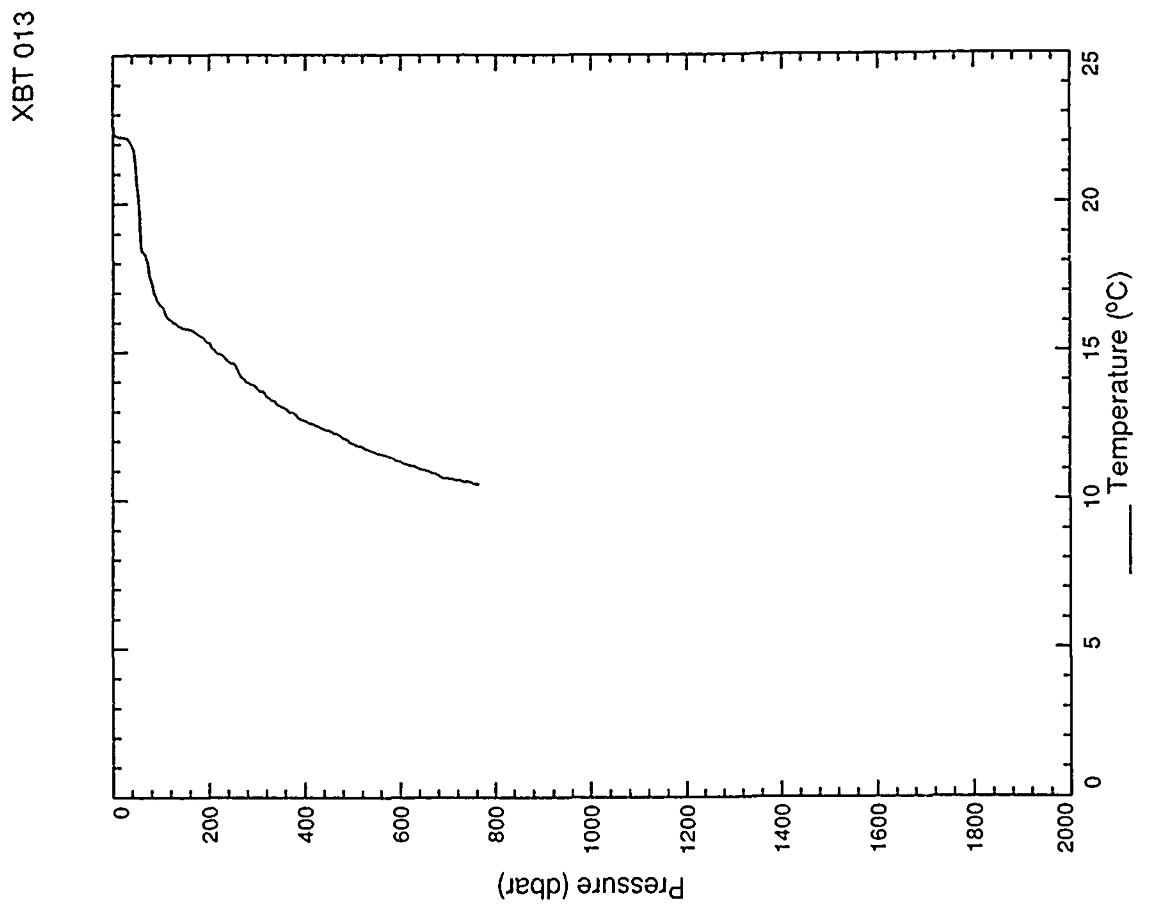

XBT 010
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 009
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

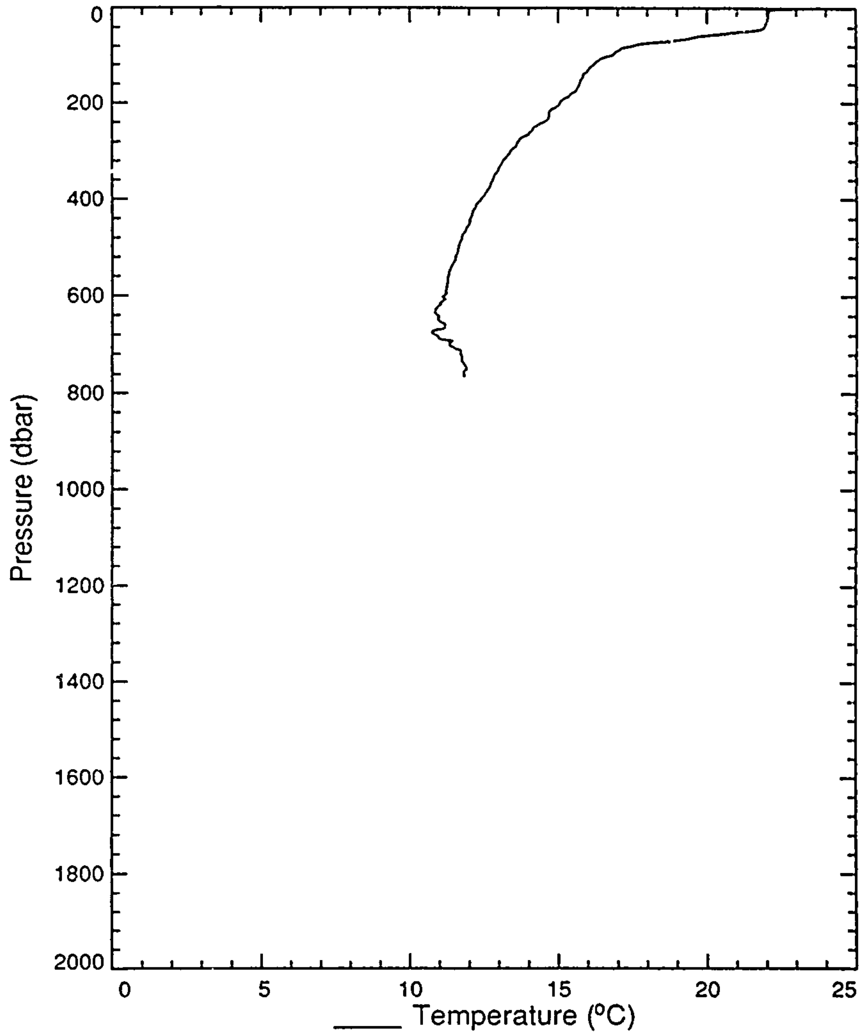

XBT 012
Temperature (ºC)
Pressure (dbar)


XBT 011
Temperature (ºC)
Pressure (dbar)

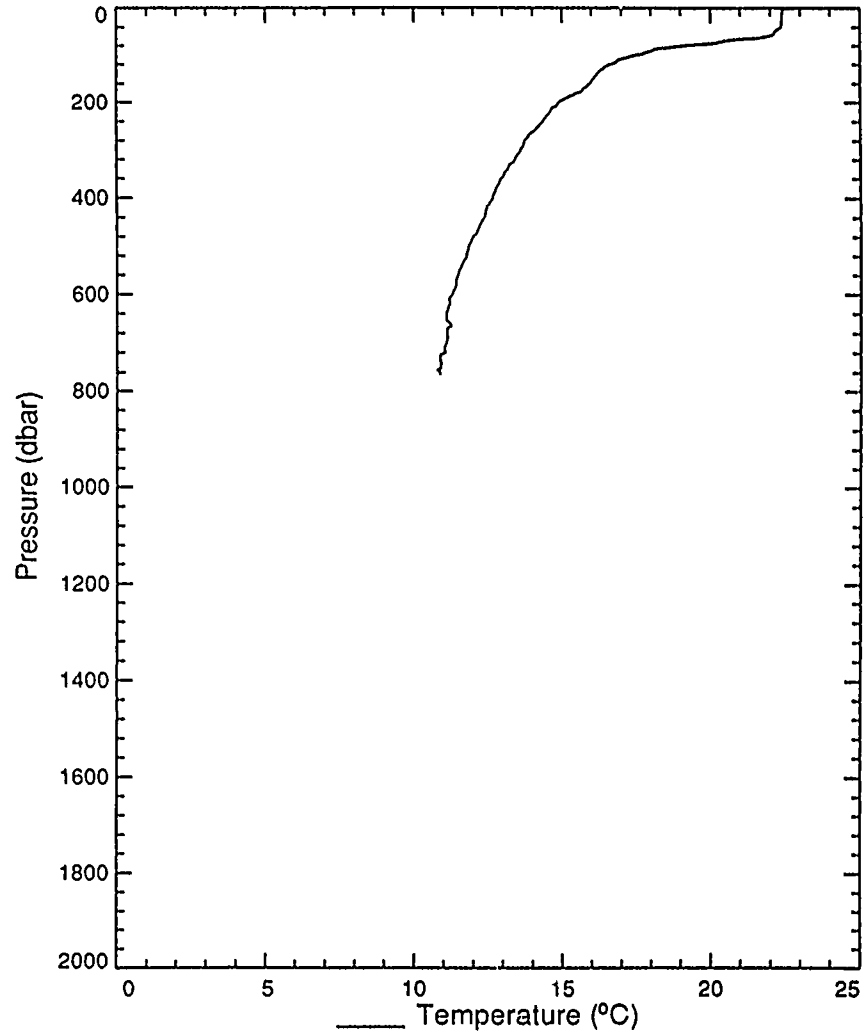

XBT 014
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

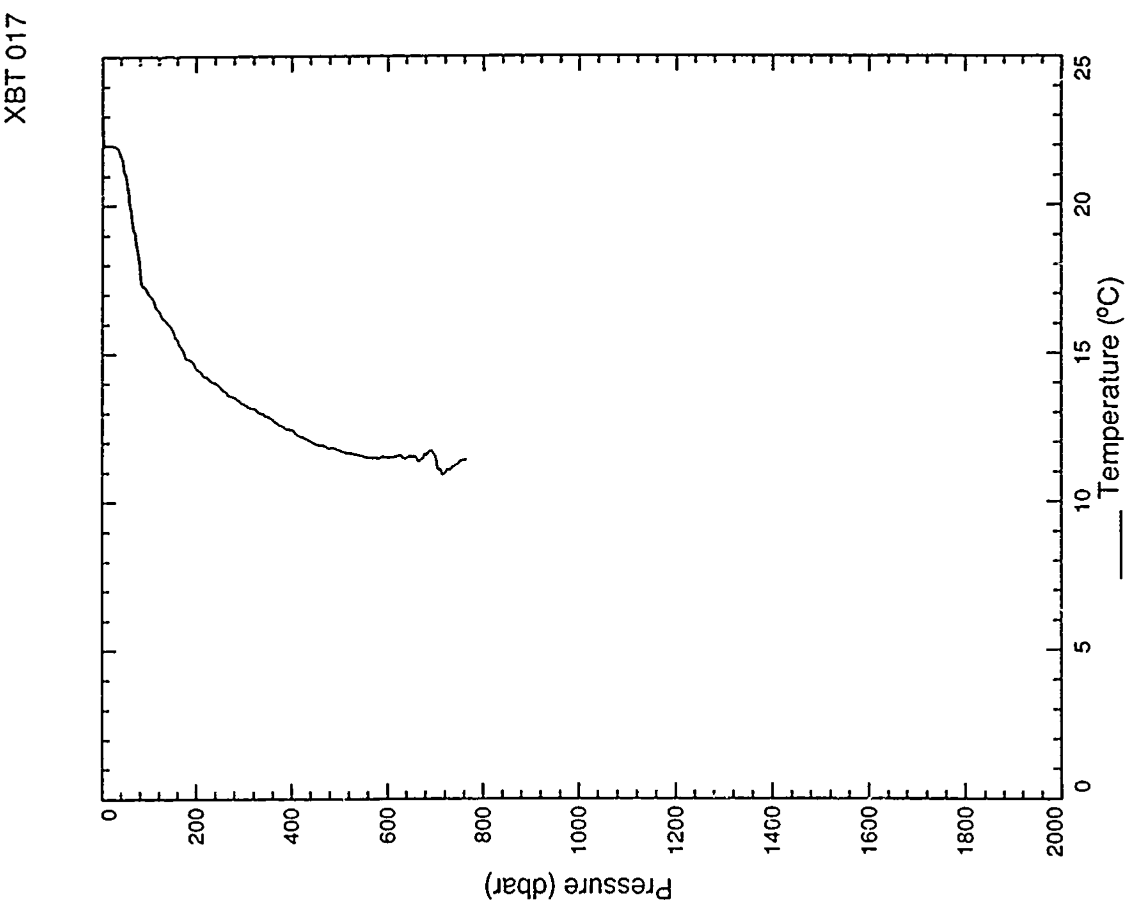

XBT 013
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

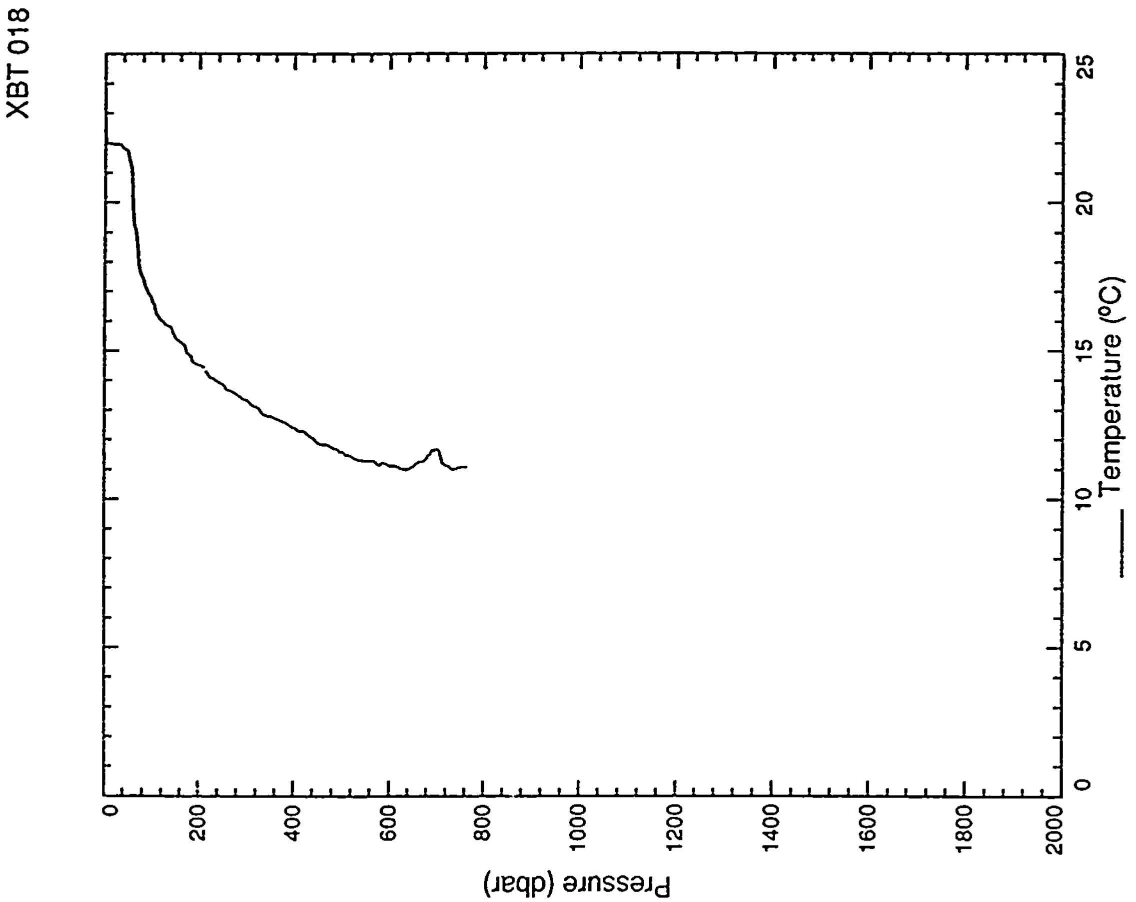
XBT 015

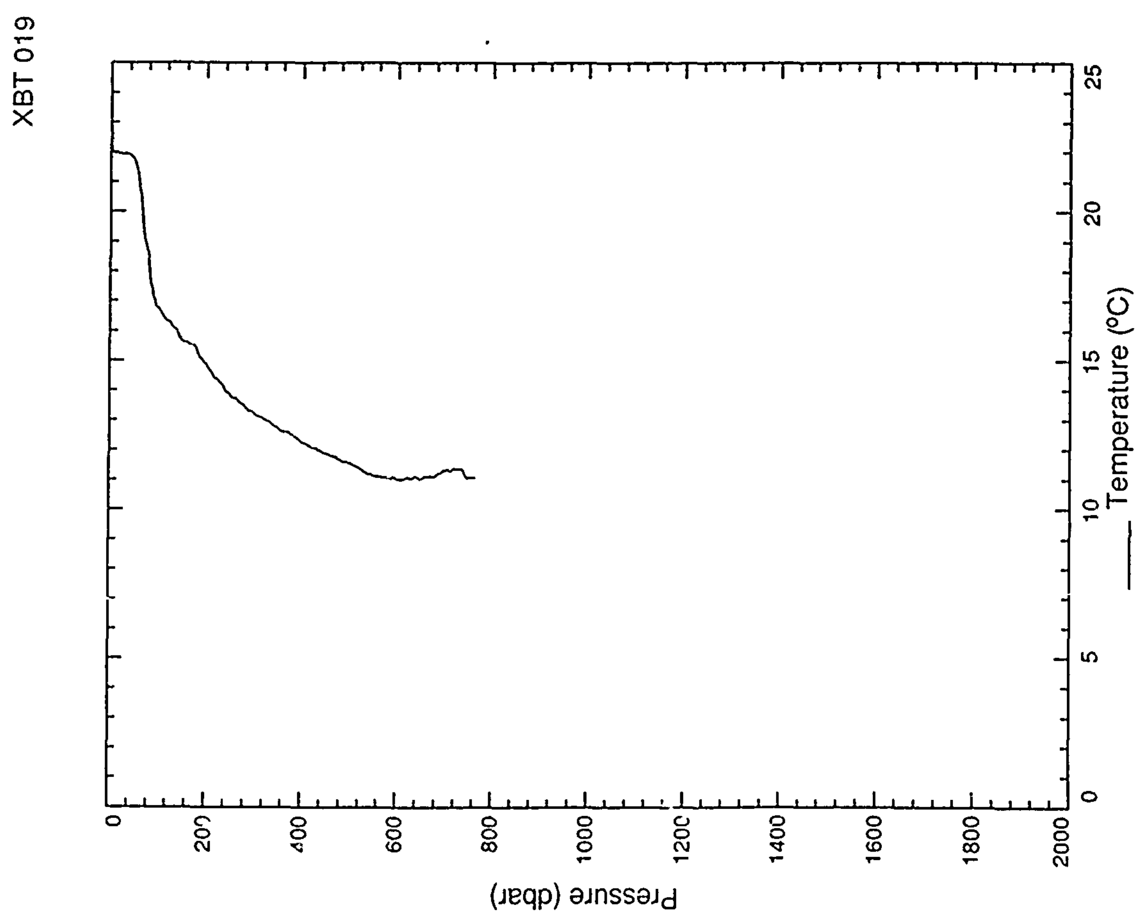


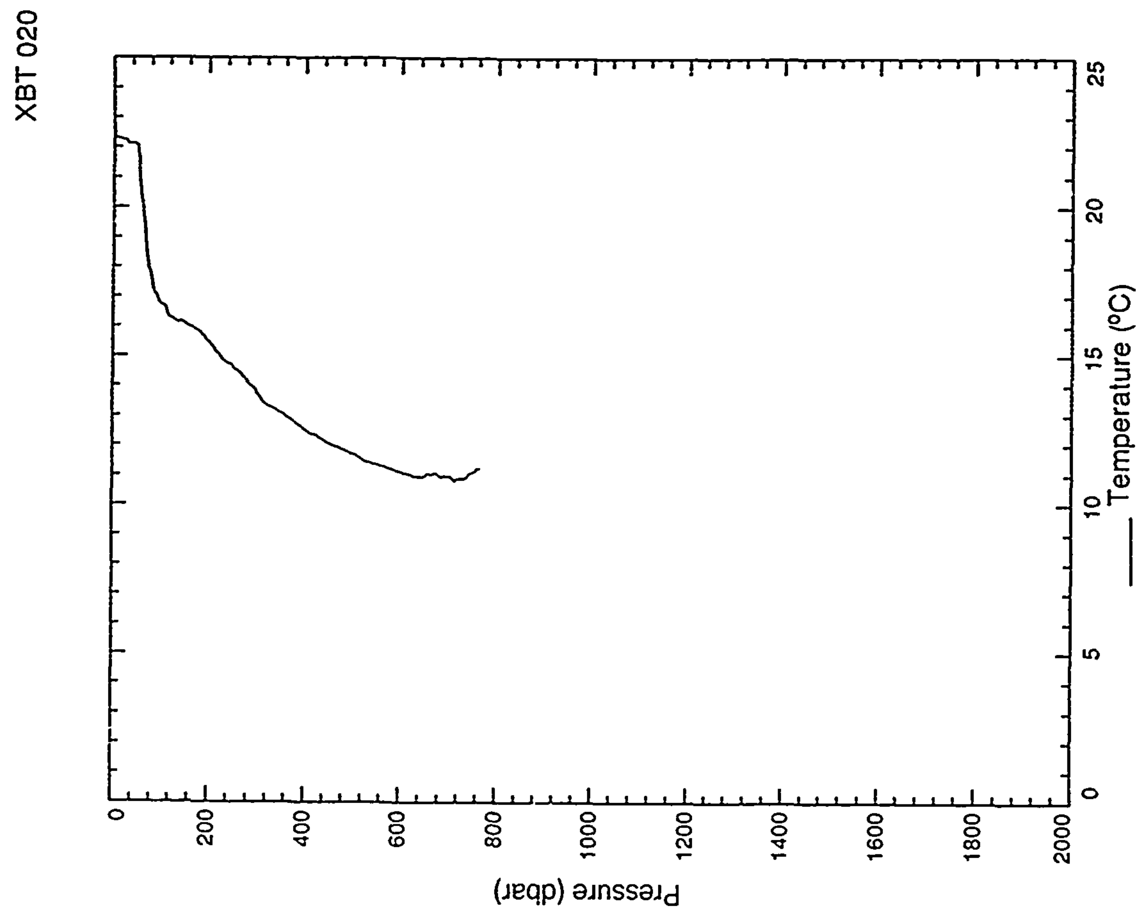
XBT 016

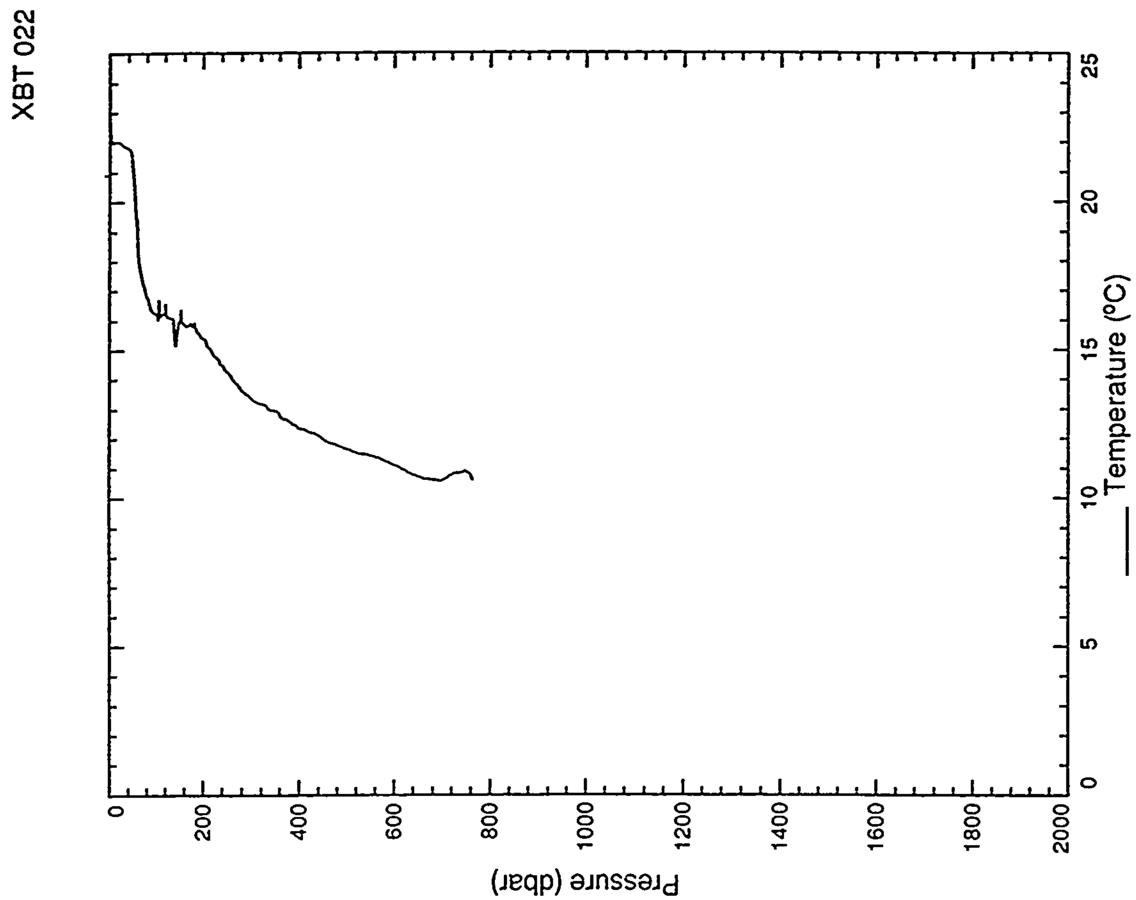


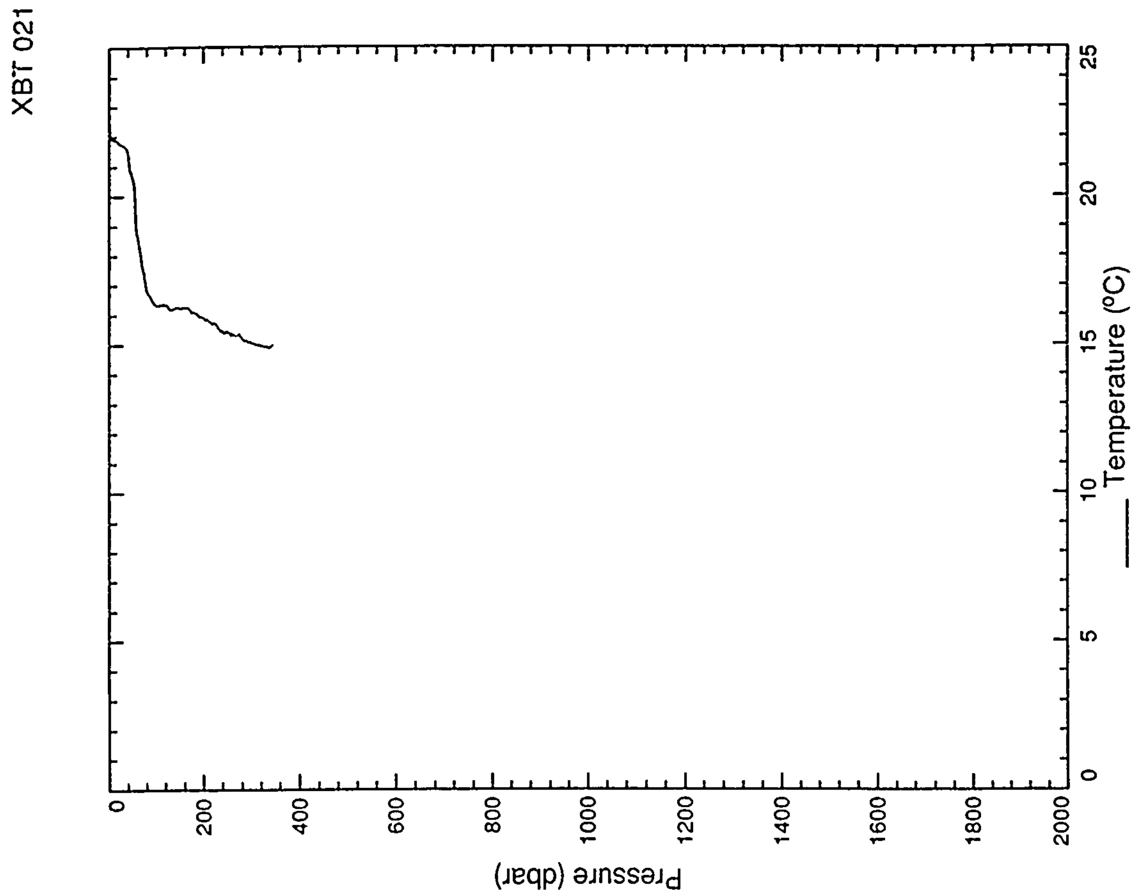

XBT 017
Pressure (dbar)
Temperature (ºC)

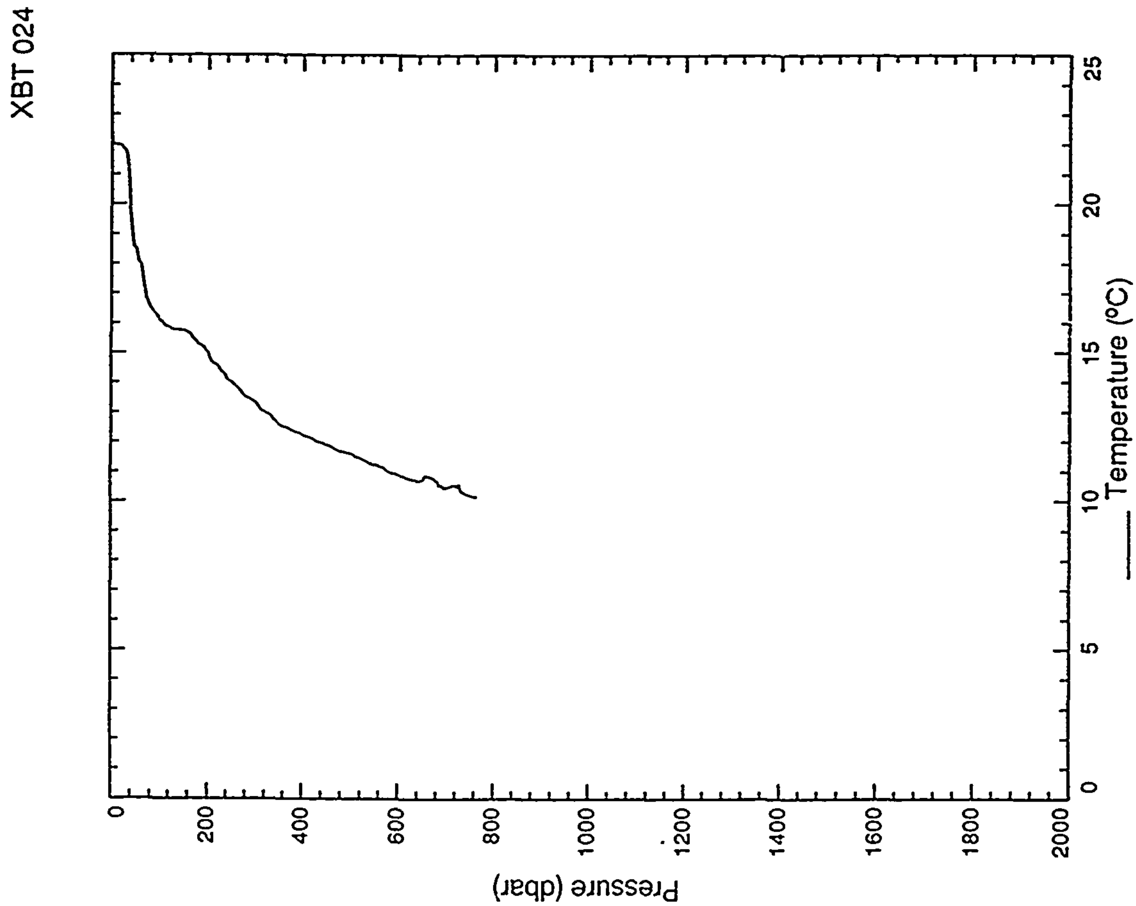

XBT 018
Pressure (dbar)
Temperature (ºC)


XBT 019
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 020
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 022
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (ºC)


XBT 021
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (ºC)


XBT 024
Pressure (dbar)
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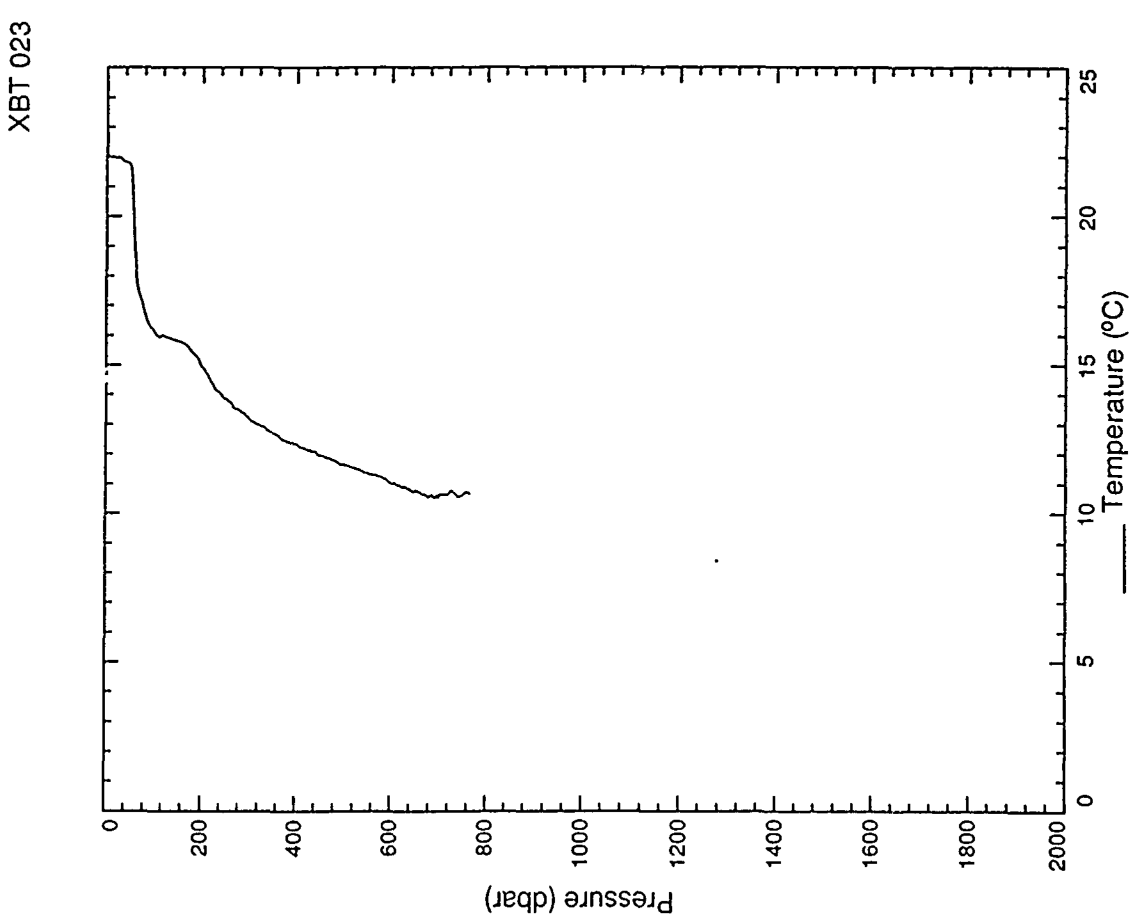
Temperature (ºC)
0 5 10 15 20 25


XBT 023
Pressure (dbar)
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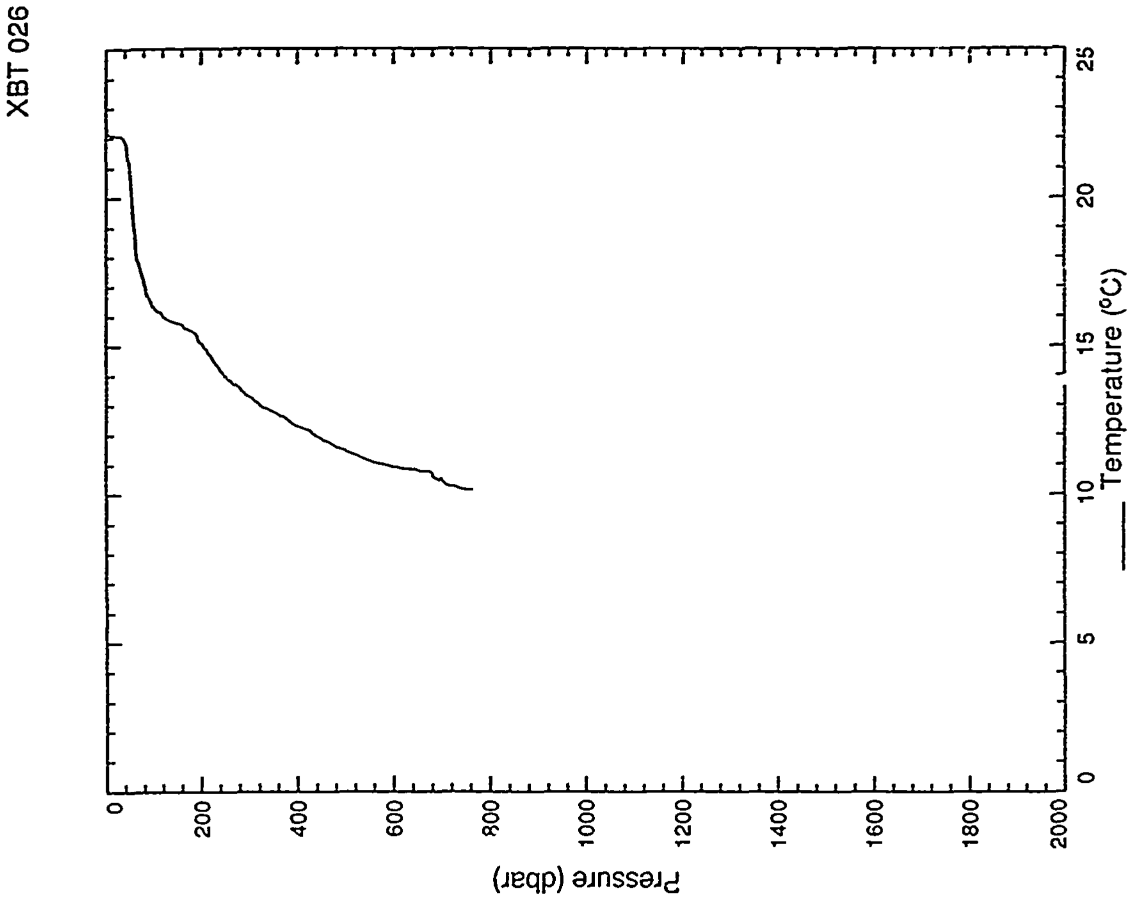
Temperature (ºC)
0 5 10 15 20 25


XBT 026
Pressure (dbar)
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200
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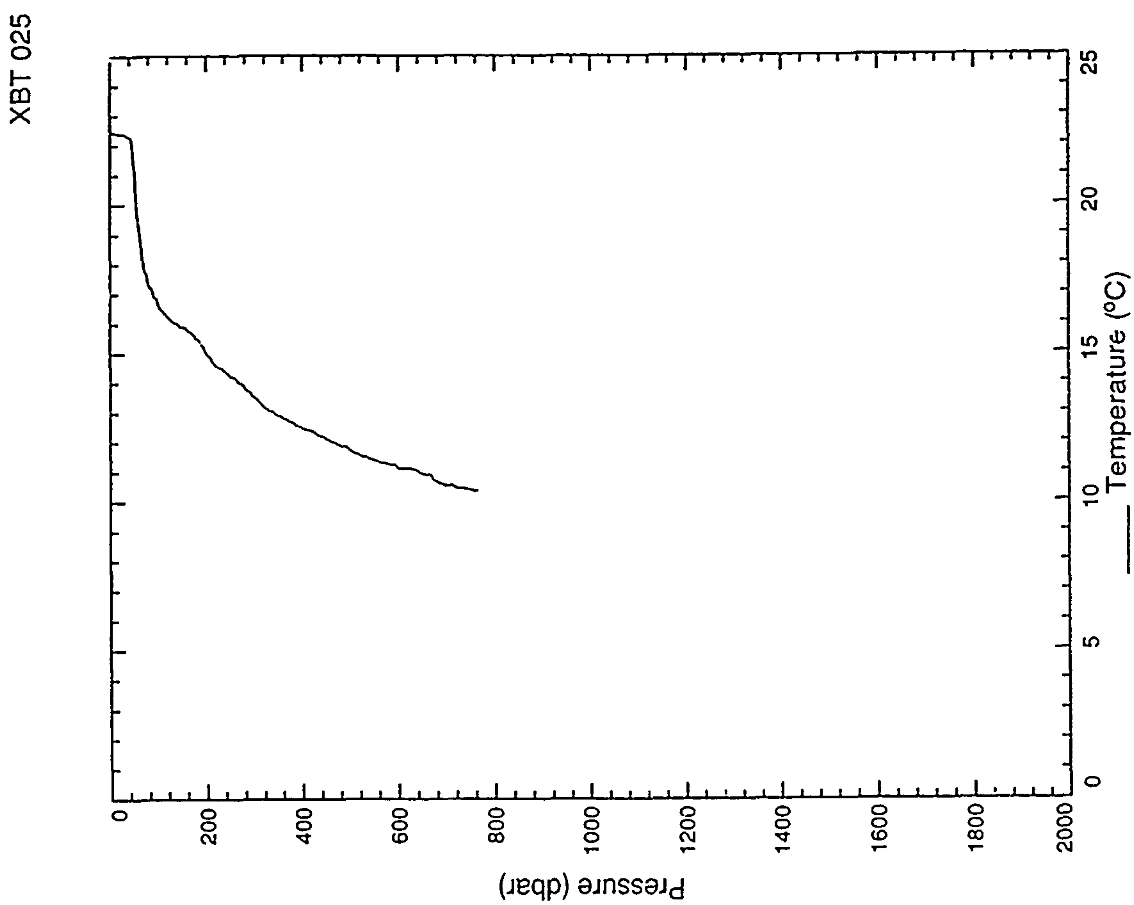
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25


XBT 025
Pressure (dbar)
0
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600
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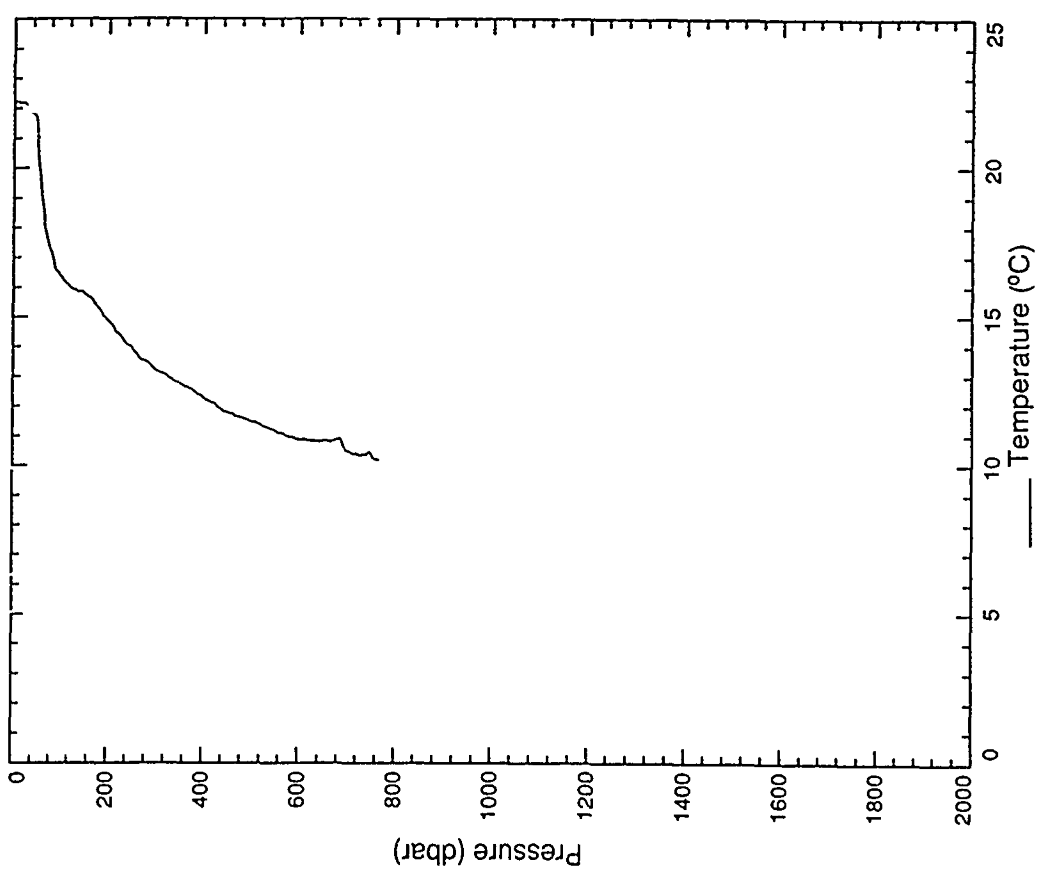
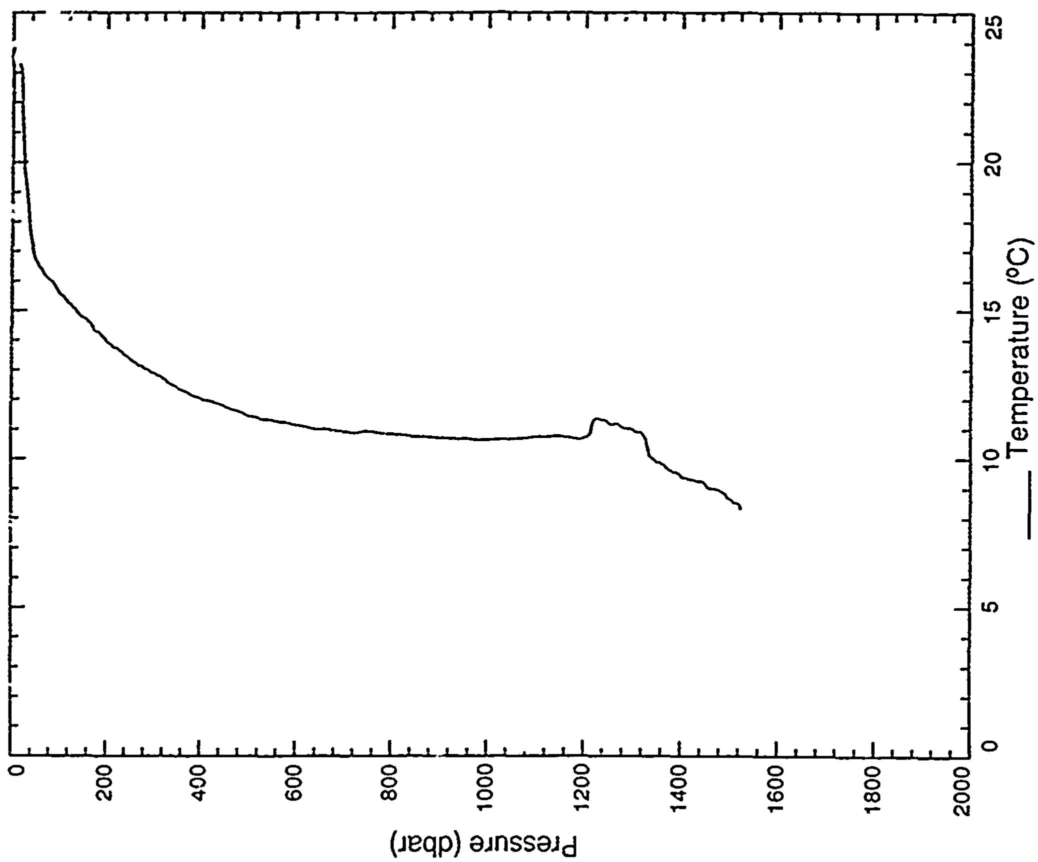
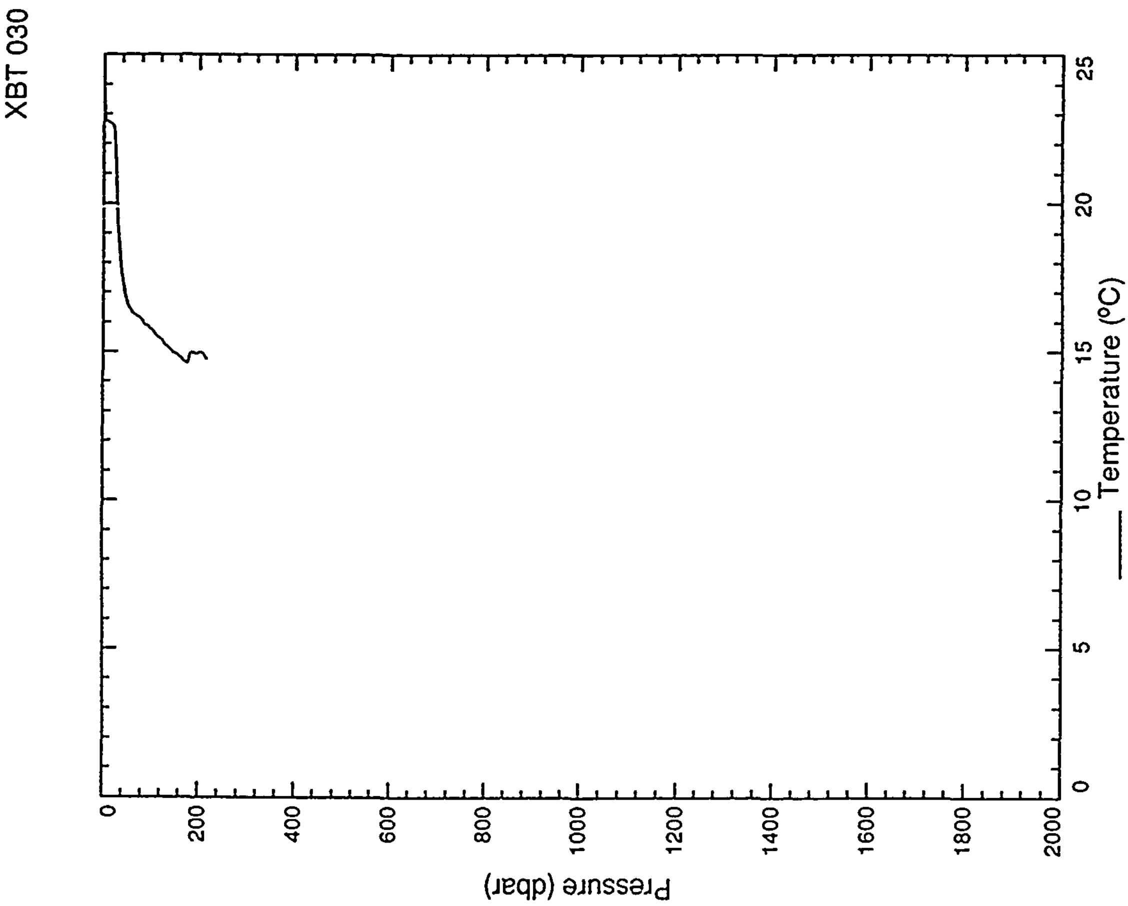
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

XBT 027



XBT 028




XBT 030
Pressure (dbar)
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800
1000
1200
1400
1600
1800
2000
Temperature (°C)
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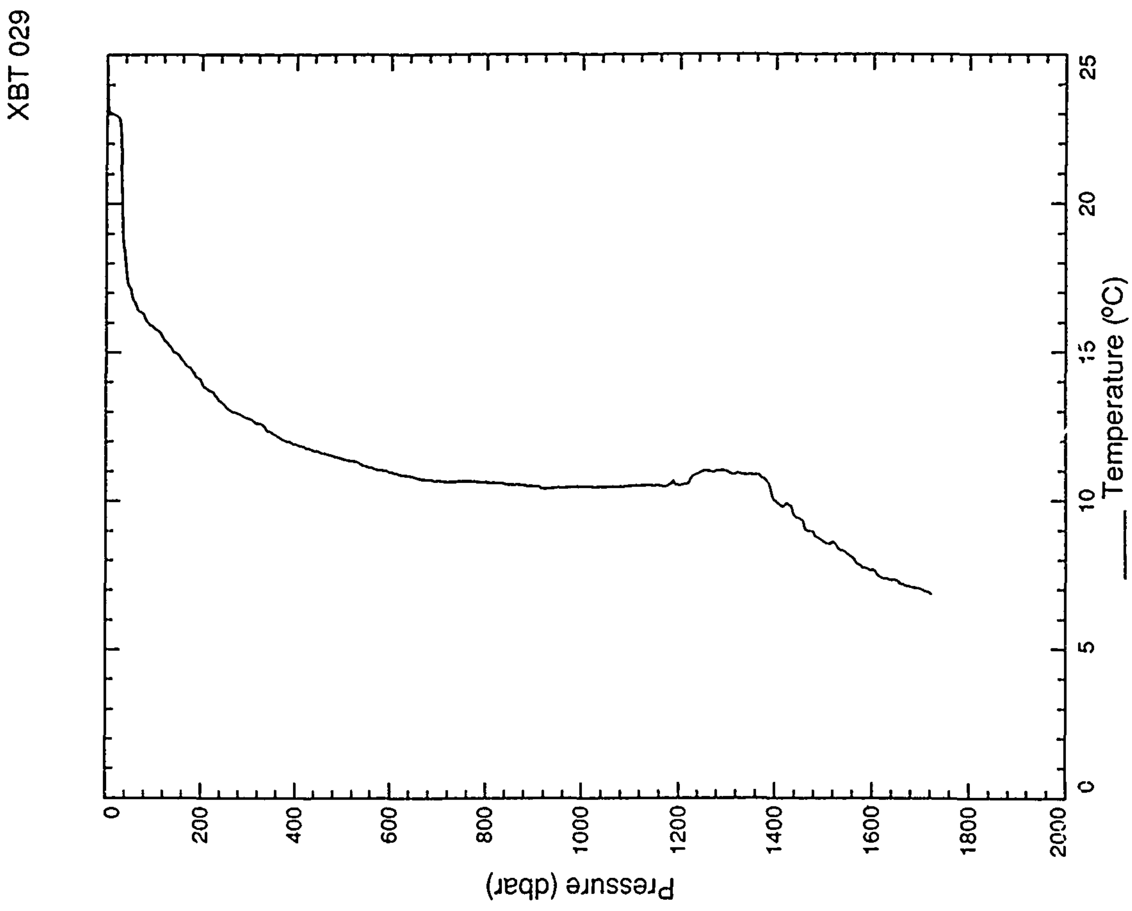
10
15
20
25


XBT 029
Pressure (dbar)
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800
1000
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1400
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2000
Temperature (°C)
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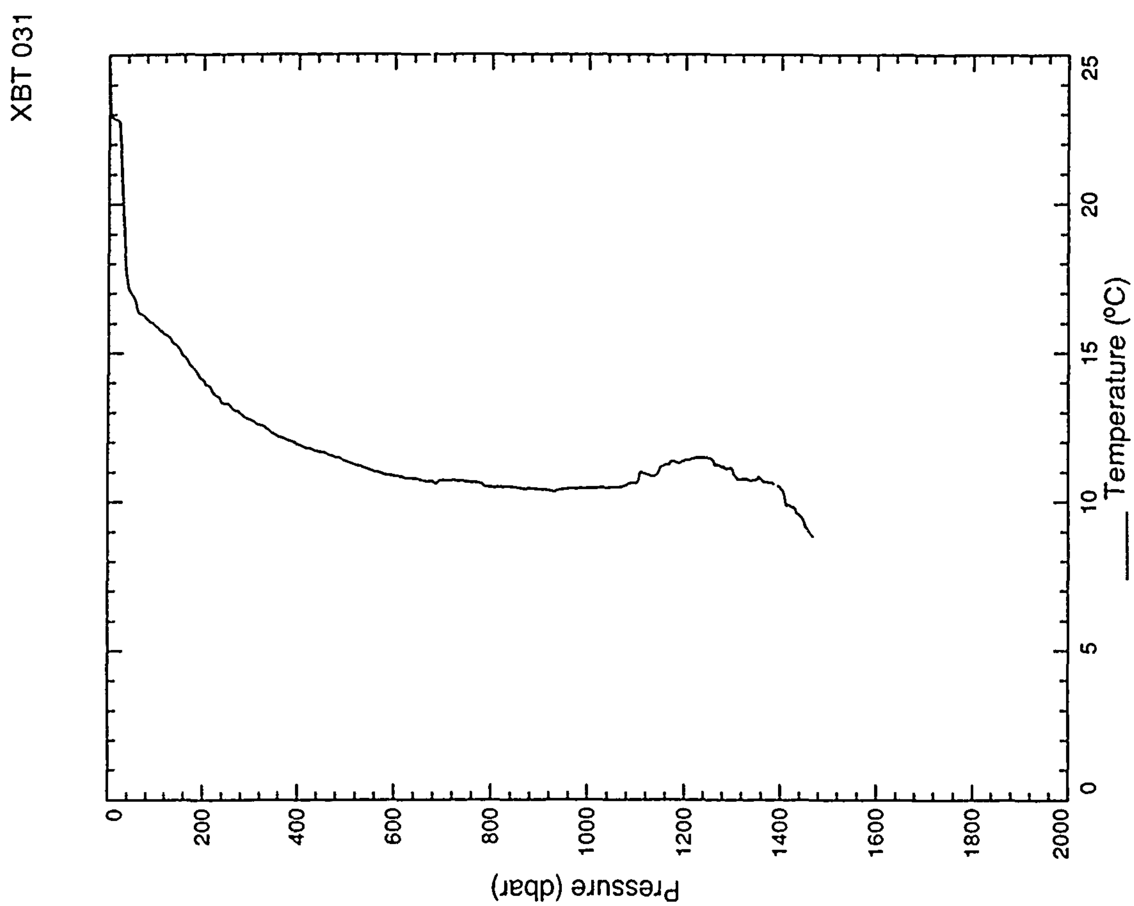
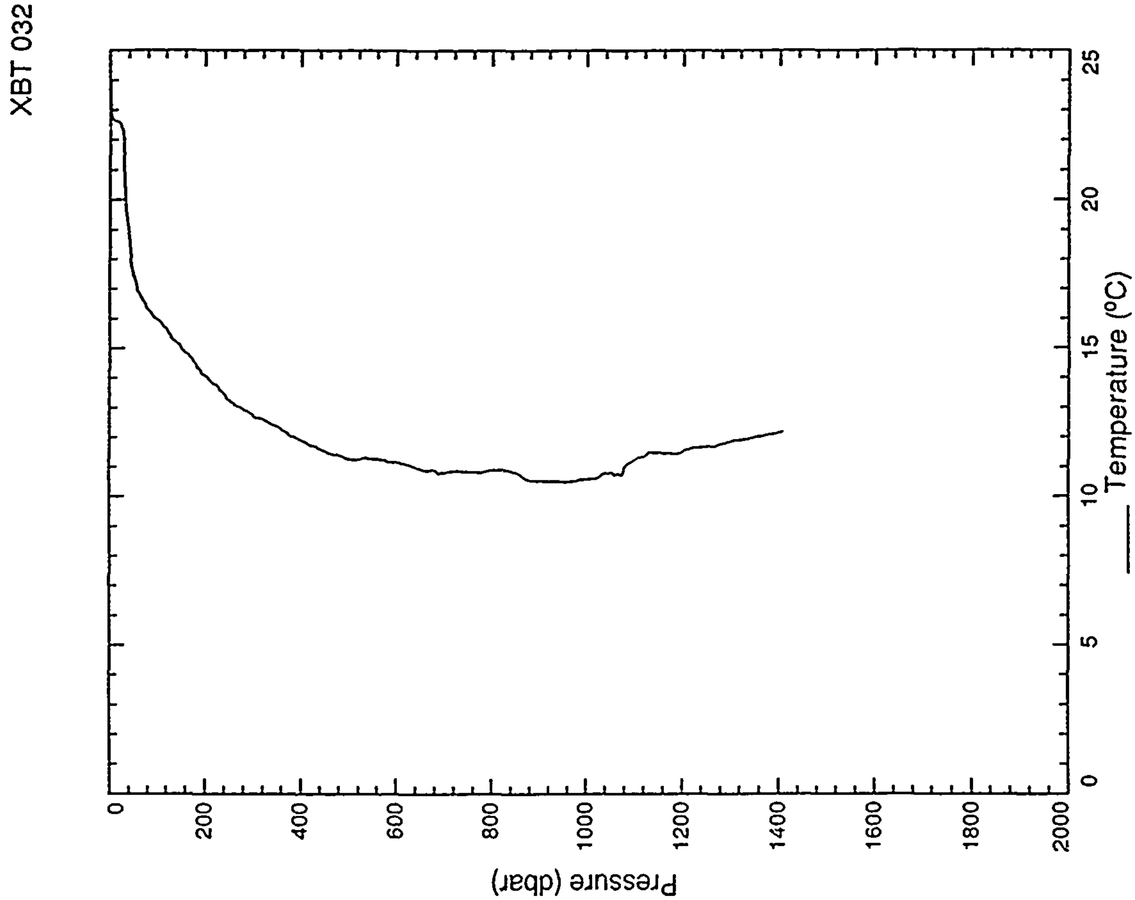
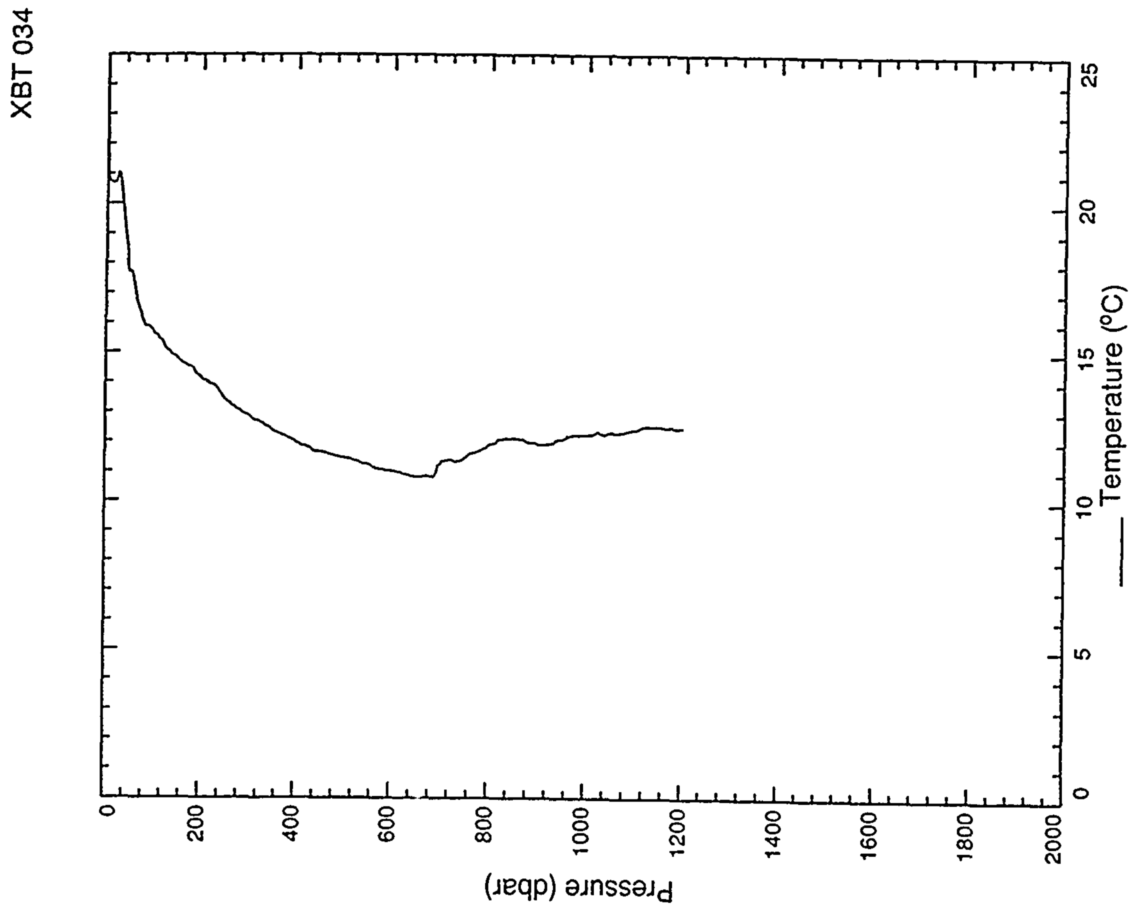
5
10
15
20
25


XBT 031
Pressure (dbar)
Temperature (°C)


XBT 032
Pressure (dbar)
Temperature (°C)


XBT 034
Pressure (dbar)
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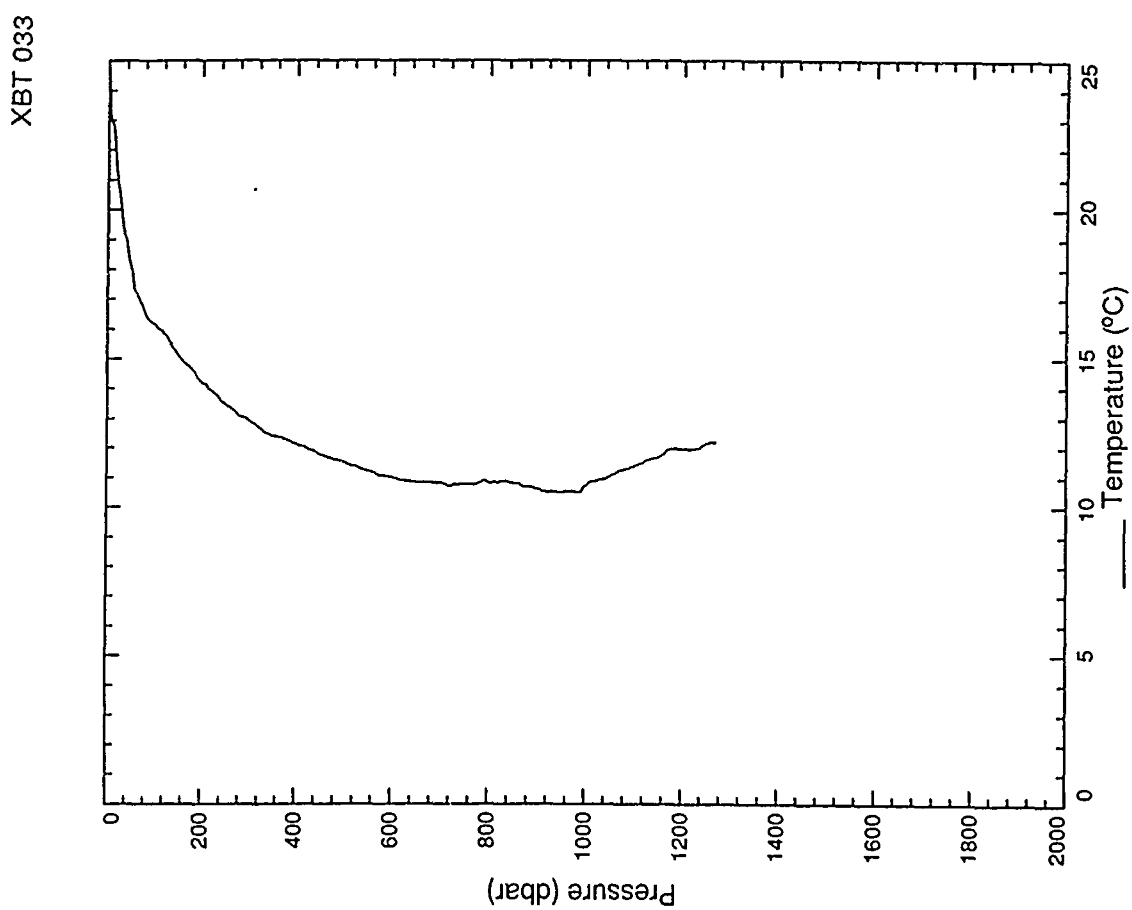
Temperature (°C)
0 5 10 15 20 25


XBT 033
Pressure (dbar)
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Temperature (°C)
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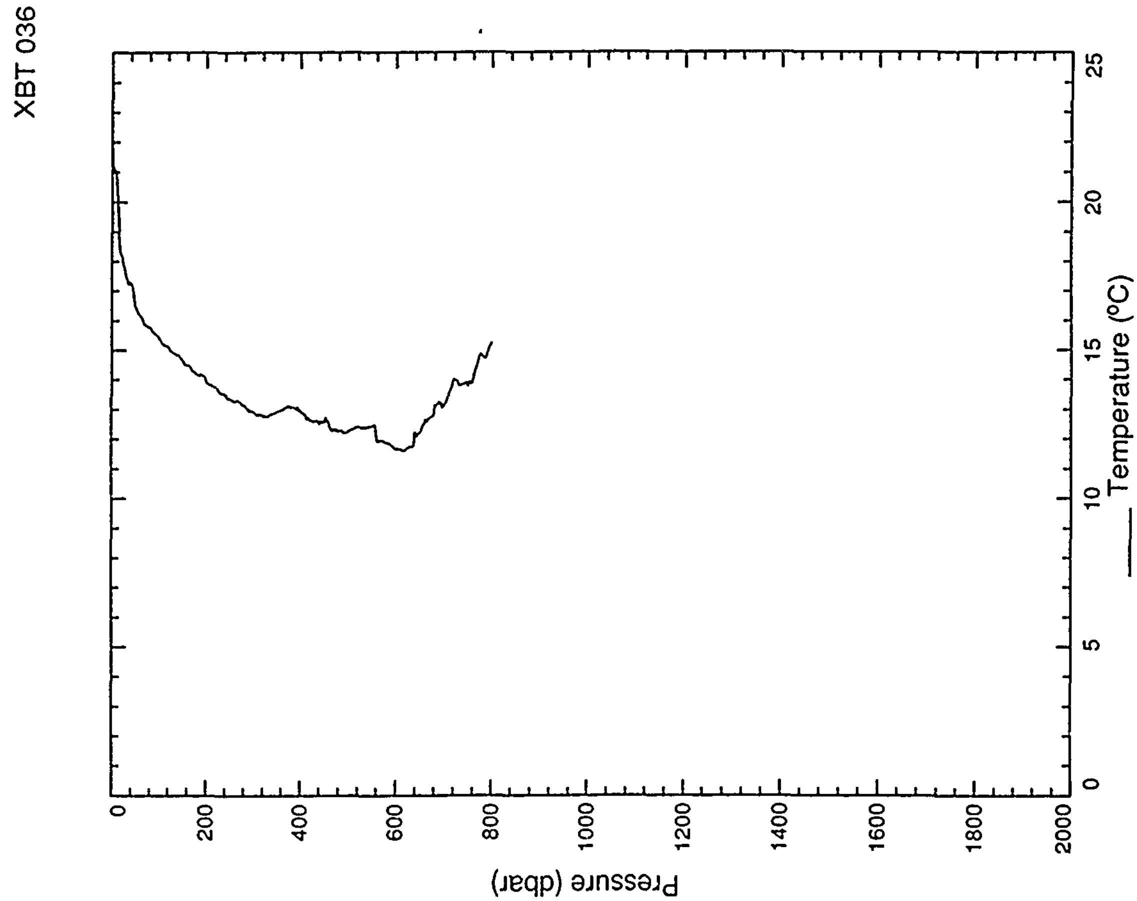
XBT 036
Pressure (dbar)
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600
800
1000
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1400
1600
1800
2000
Temperature (ºC)
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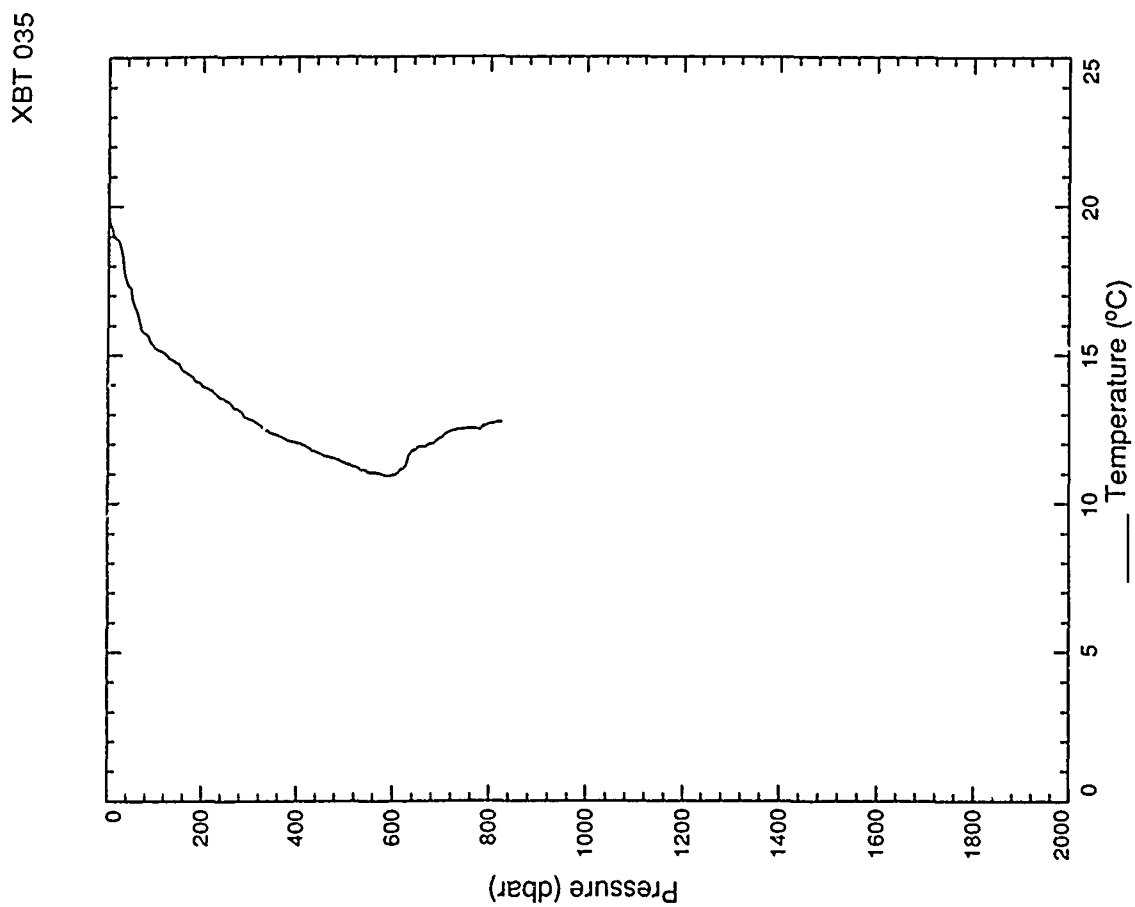
5
10
15
20
25


XBT 035
Pressure (dbar)
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800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
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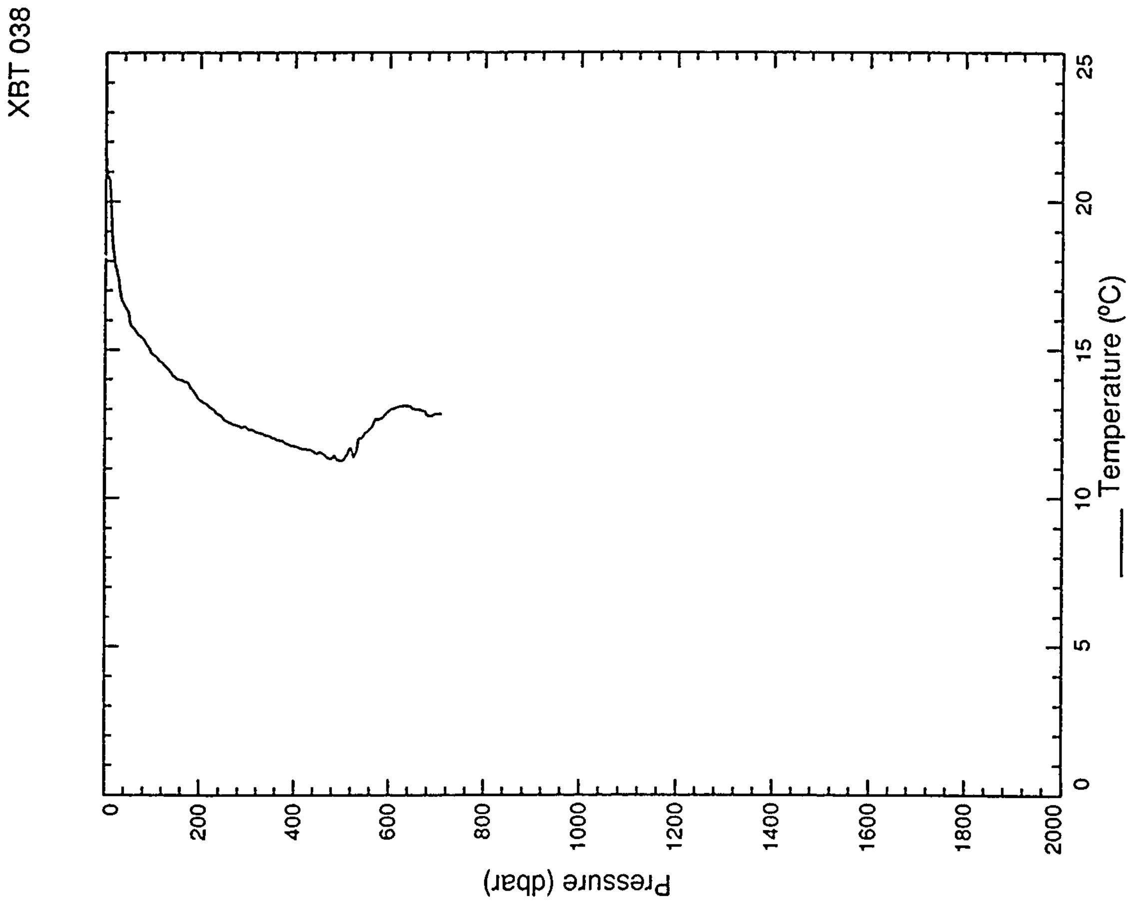
5
10
15
20
25


XBT 038
Pressure (dbar)
Temperature (ºC)
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800
1000
1200
1400
1600
1800
2000
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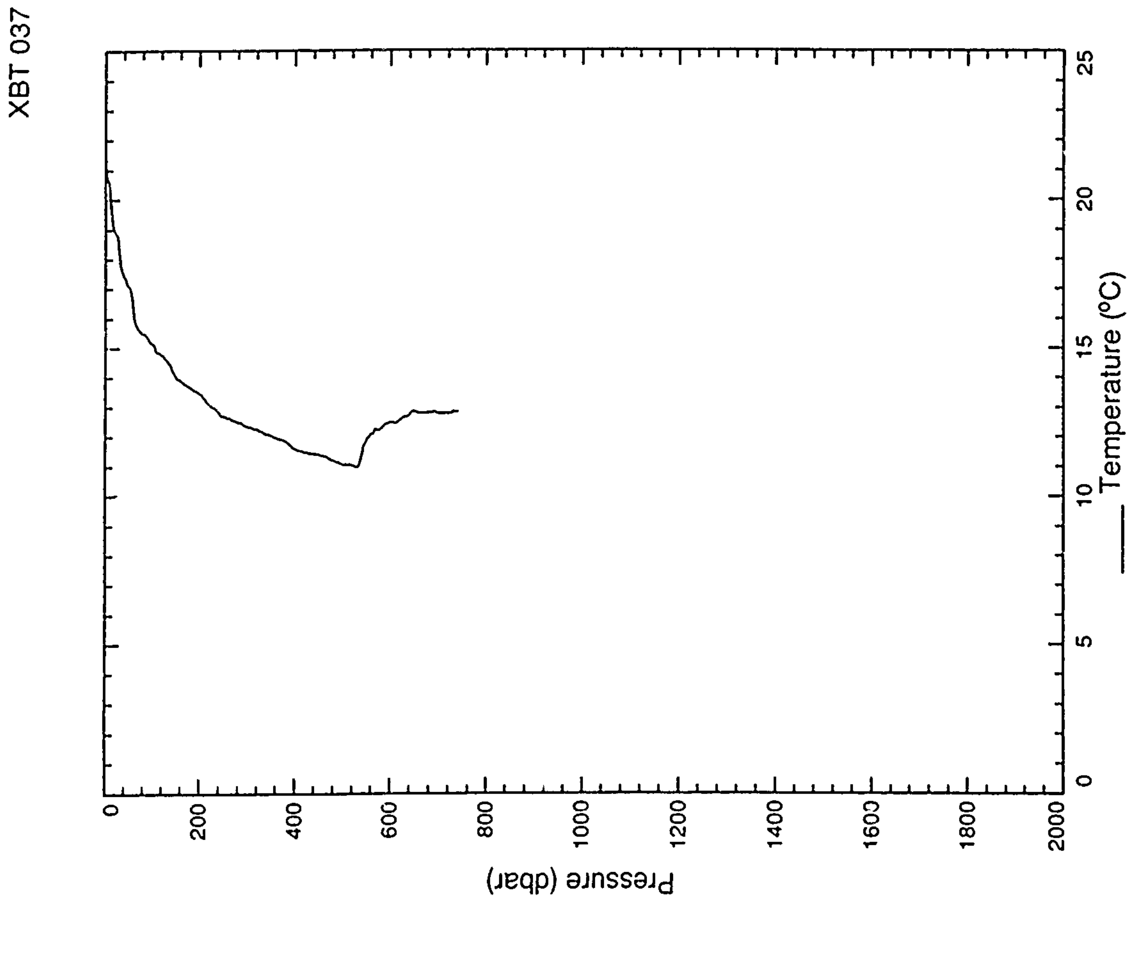
5
10
15
20
25


XBT 037
Pressure (dbar)
Temperature (ºC)
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1400
1600
1800
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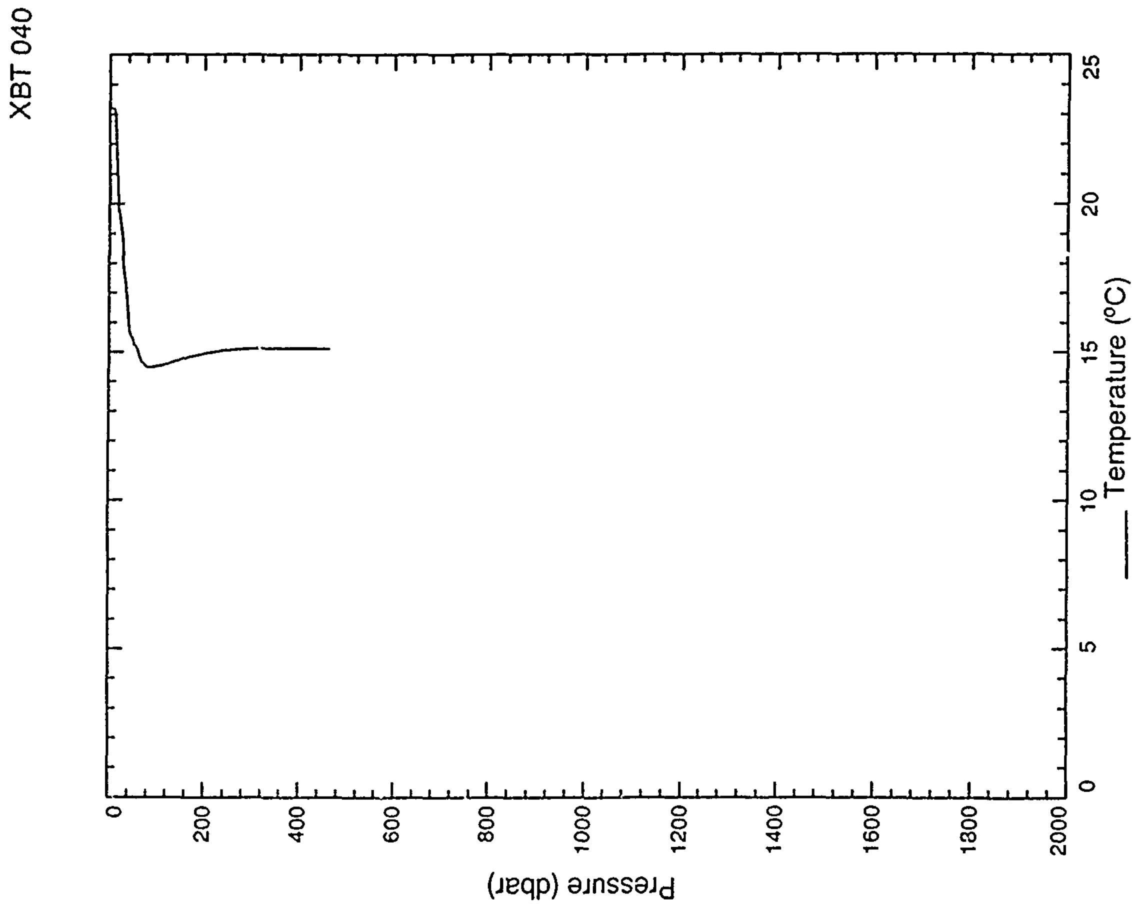
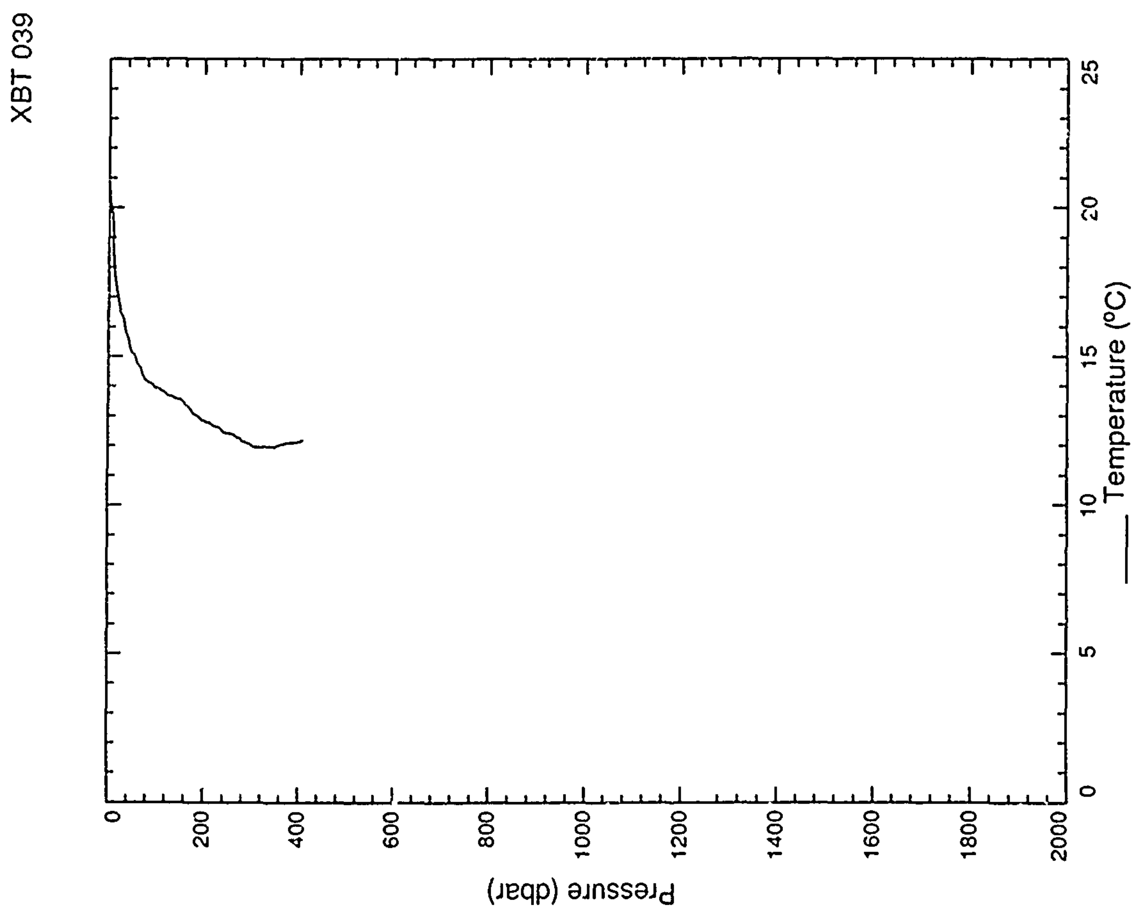
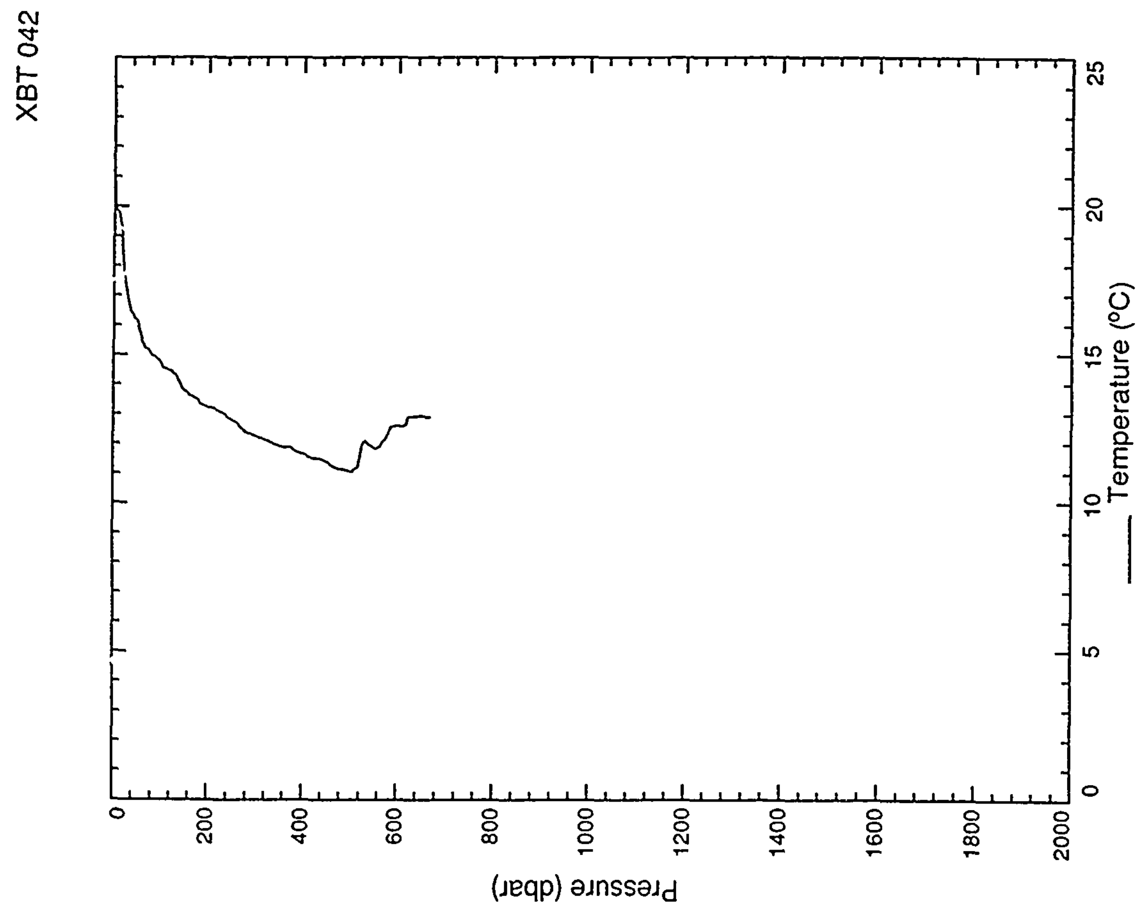
10
15
20
25


XBT 040
Temperature (°C)
Pressure (dbar)


XBT 039
Temperature (°C)
Pressure (dbar)


XBT 042
Pressure (dbar)
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1200
1400
1600
1800
2000
Temperature (°C)
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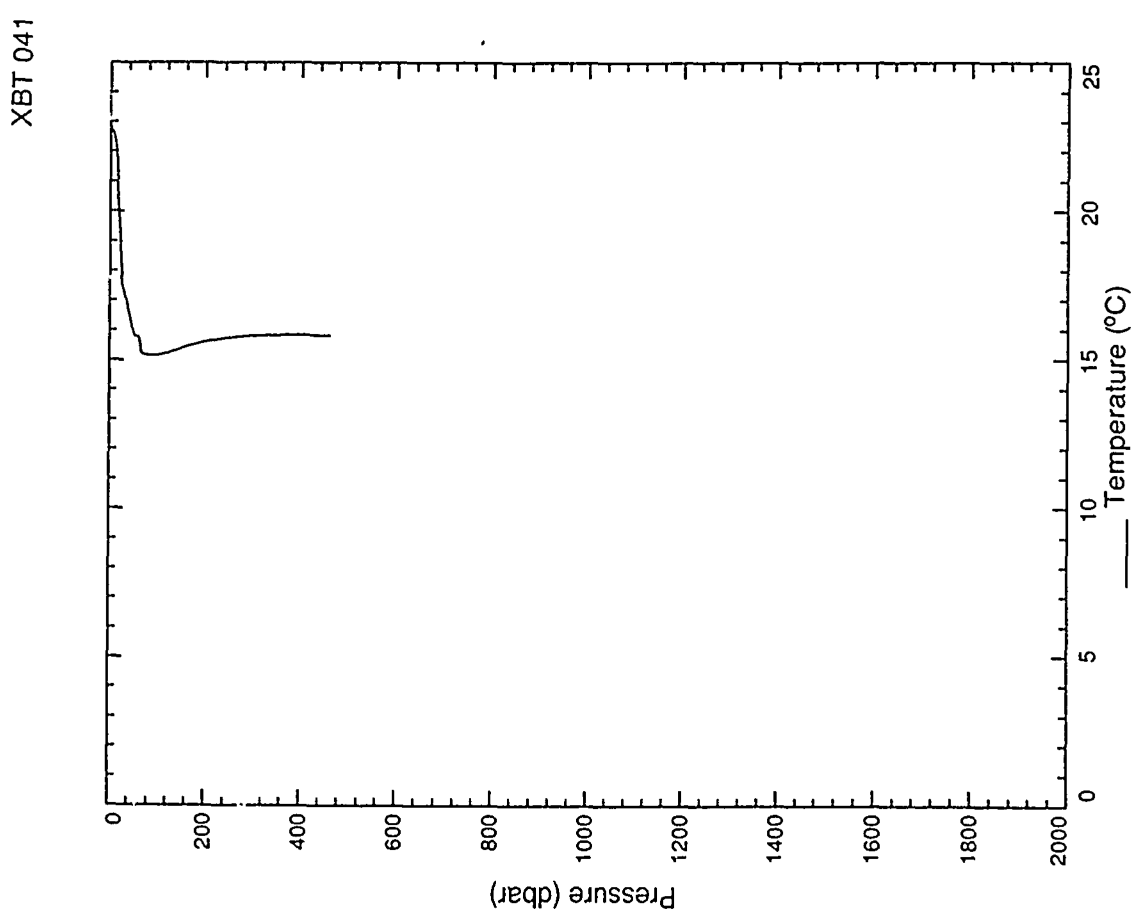
10
15
20
25


XBT 041
Pressure (dbar)
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1600
1800
2000
Temperature (°C)
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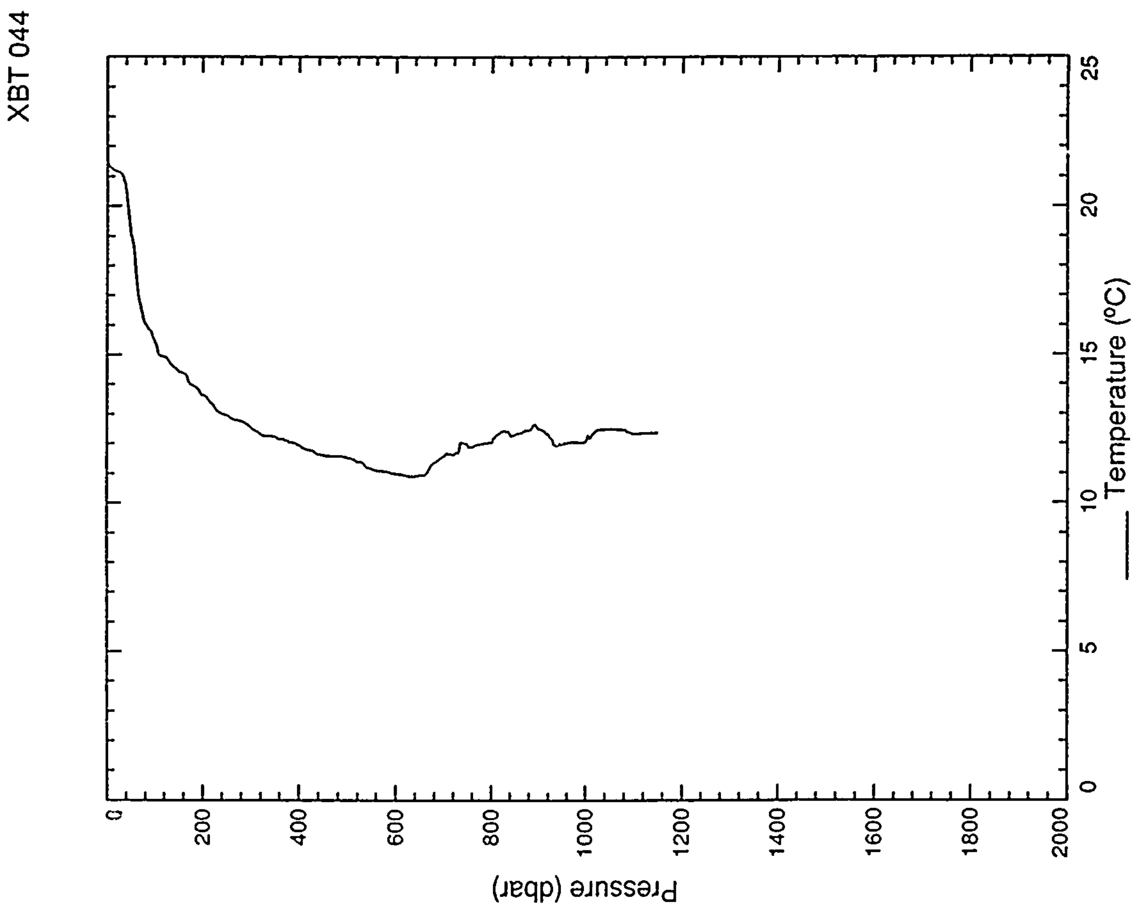
10
15
20
25


XBT 044
Pressure (dbar)
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1600
1800
2000
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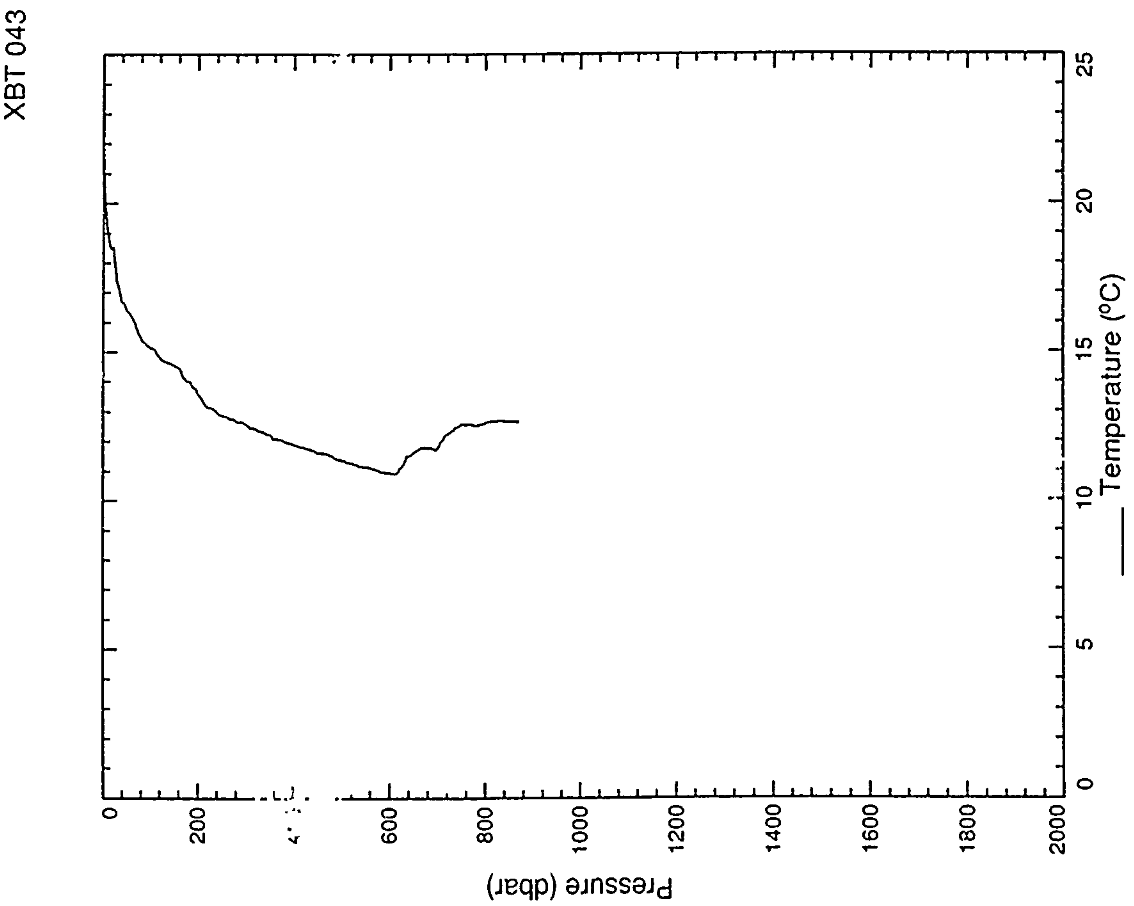
10
15
20
25
Temperature (ºC)


XBT 043
Pressure (dbar)
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2000
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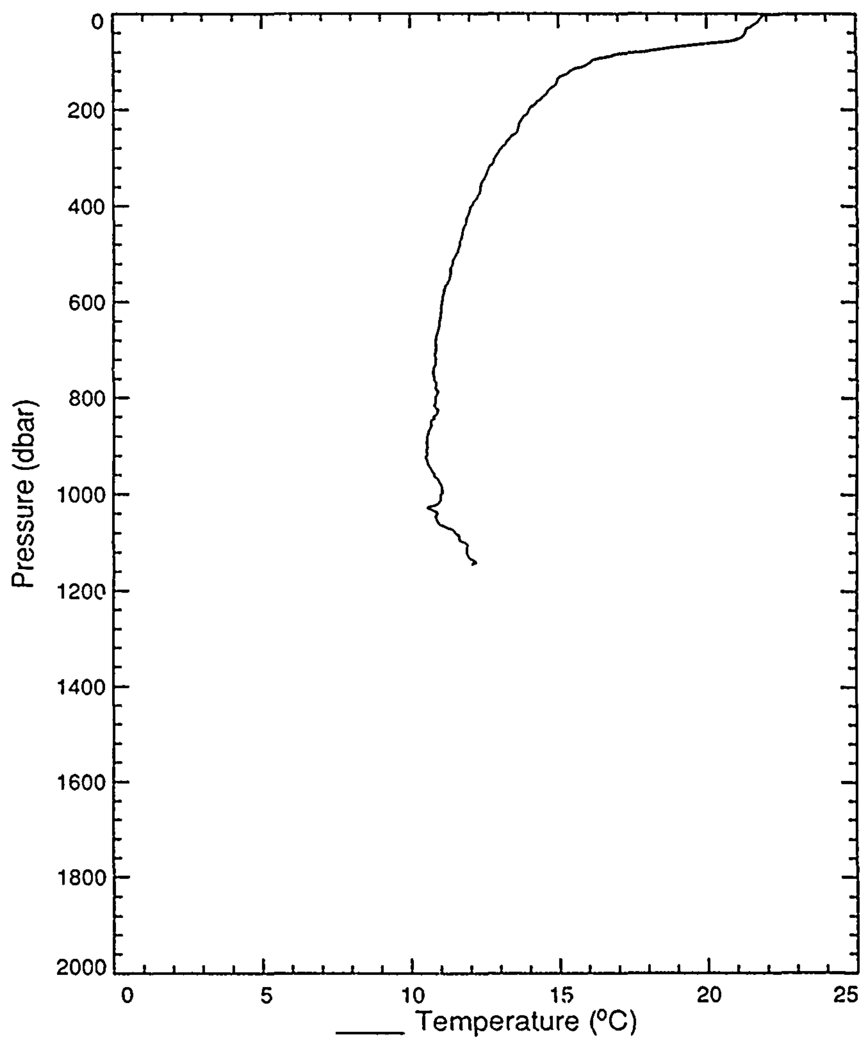
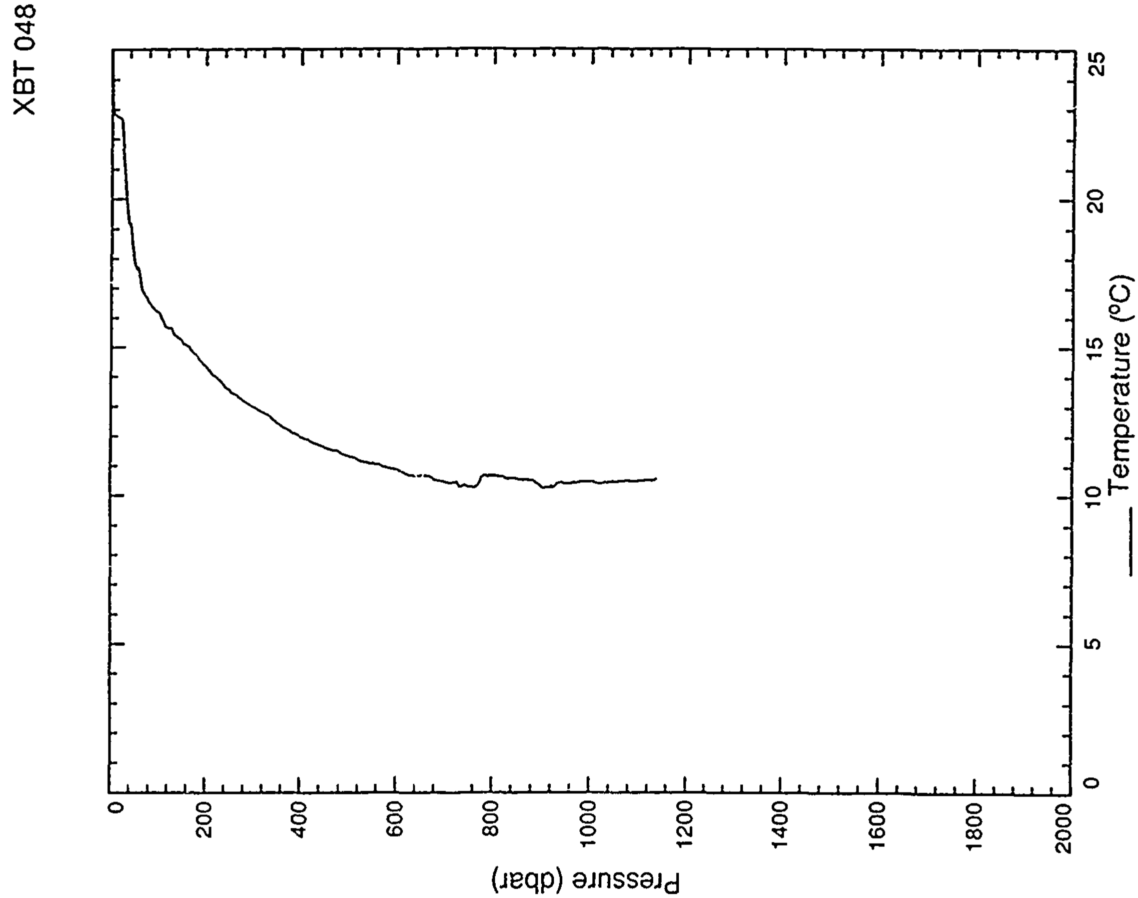
15
20
25
Temperature (ºC)

XBT 045

On Backup Tape Only

XBT 046




XBT 048
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Temperature (°C)
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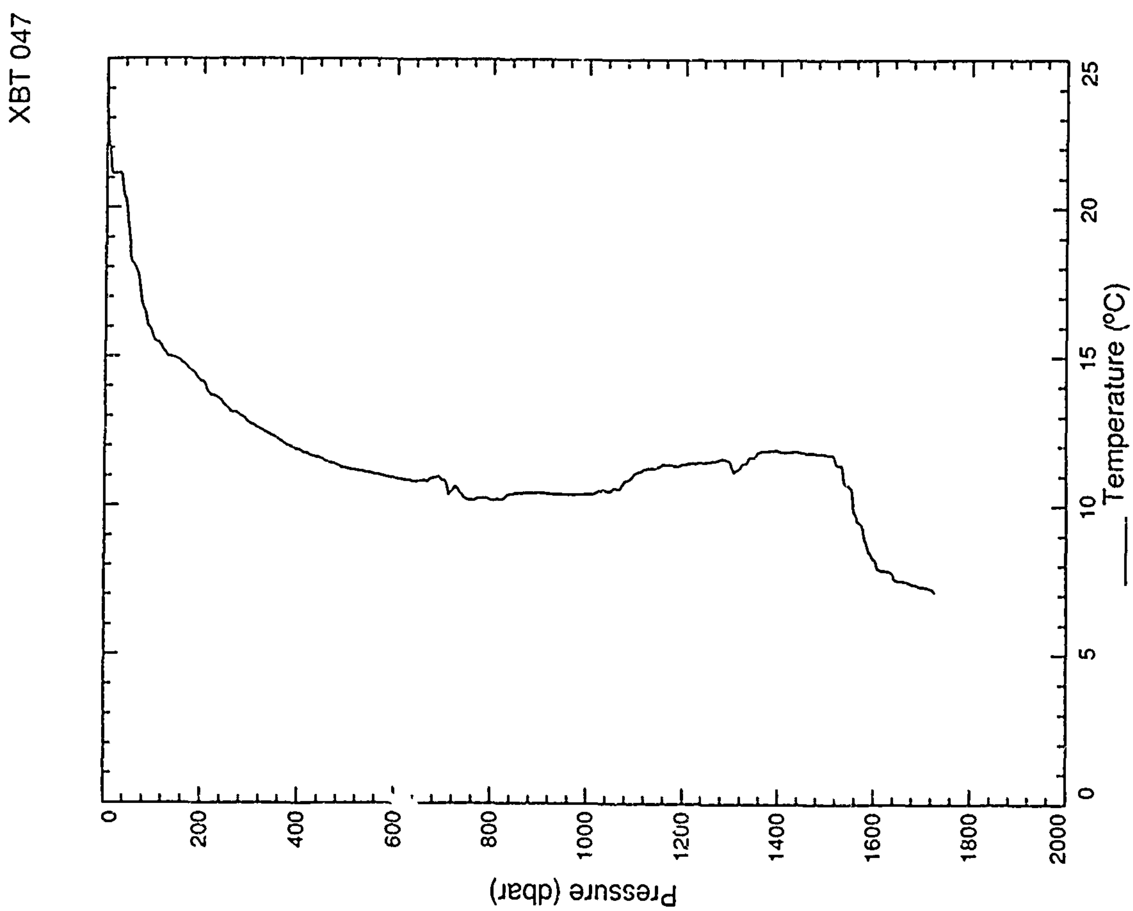
20
25


XBT 047
Pressure (dbar)
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1800
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Temperature (°C)
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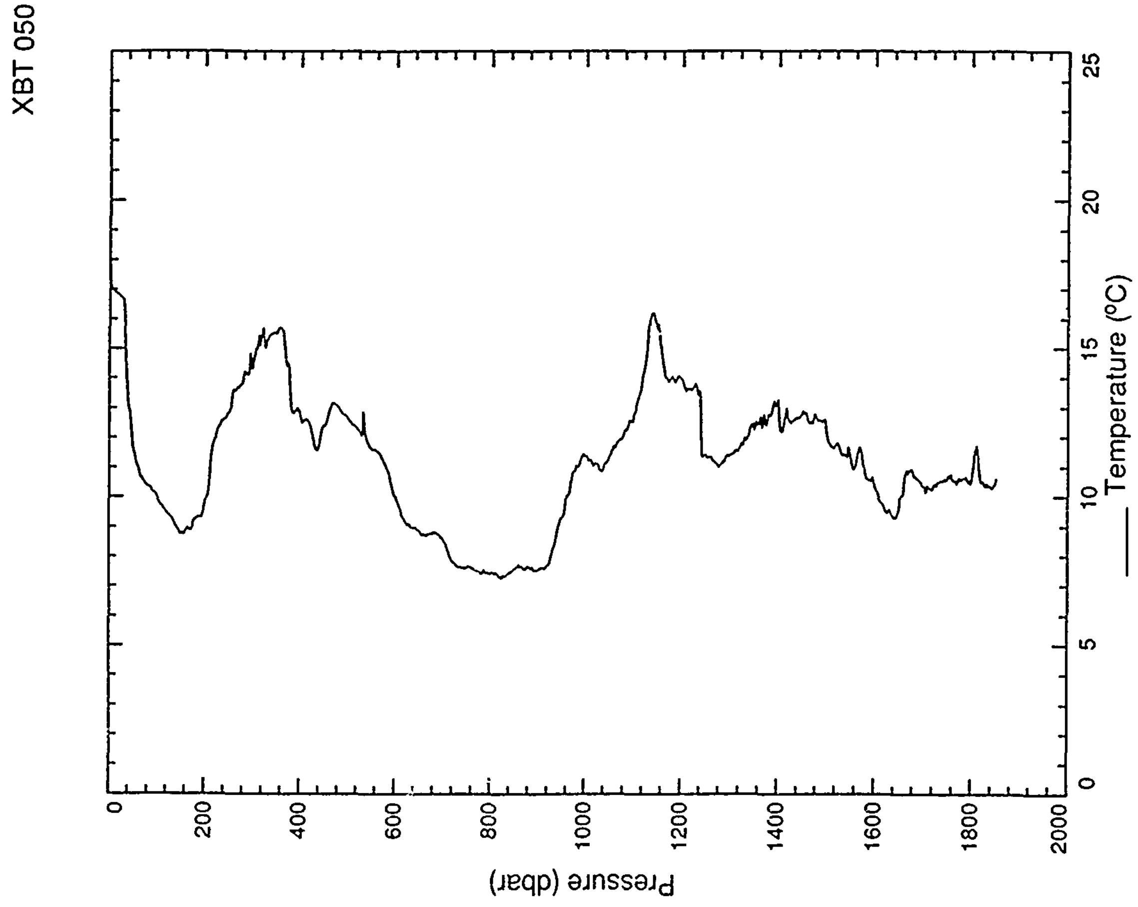
10
15
20
25


XBT 050
Pressure (dbar)
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1400
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Temperature (ºC)
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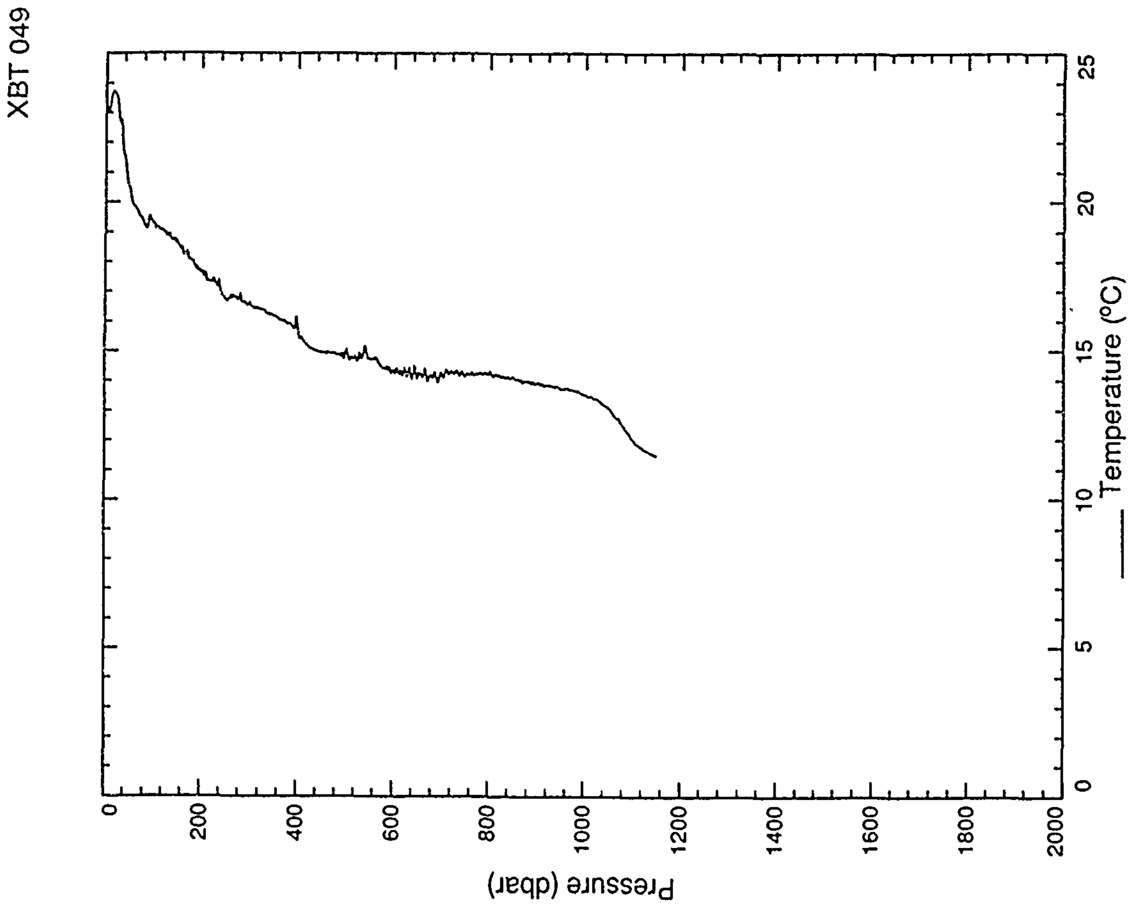
15
20
25


XBT 049
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1800
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Temperature (ºC)
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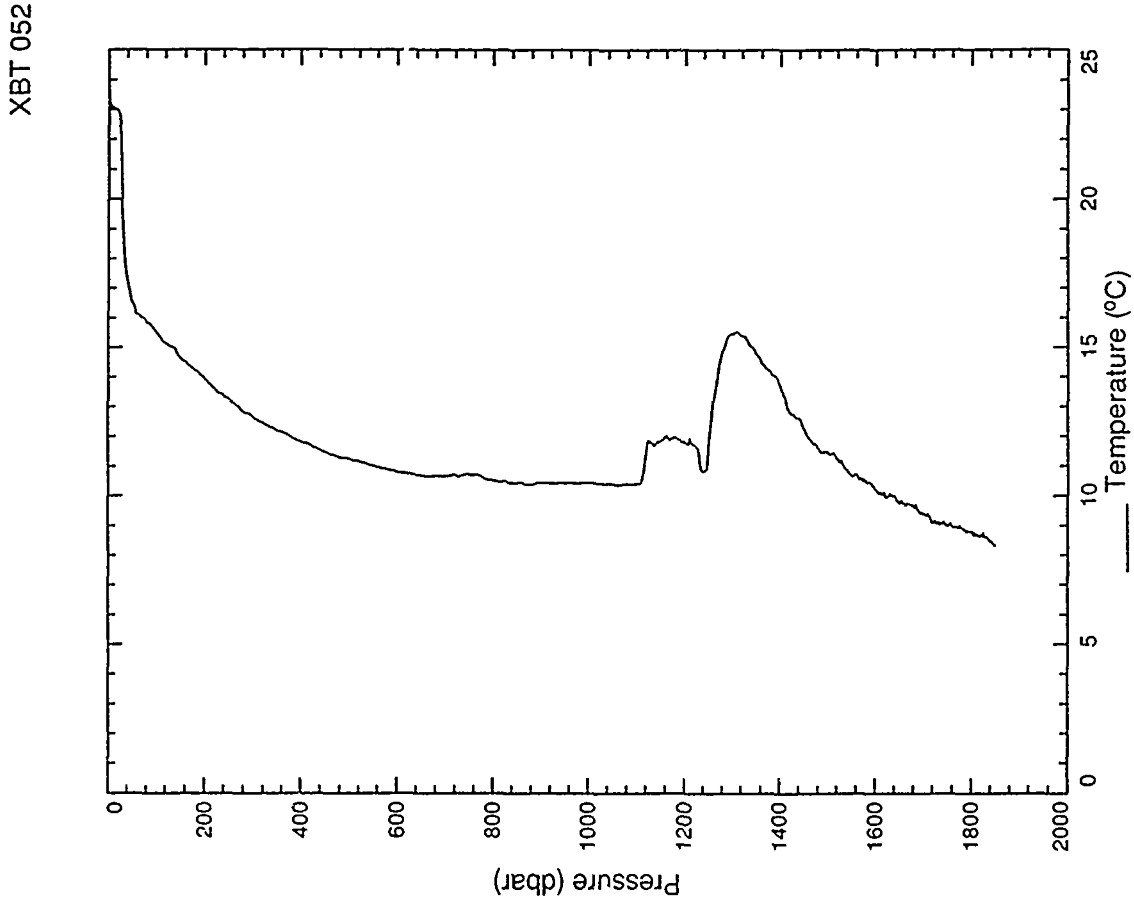
15
20
25


XBT 052
Pressure (dbar)
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1800
2000
Temperature (ºC)
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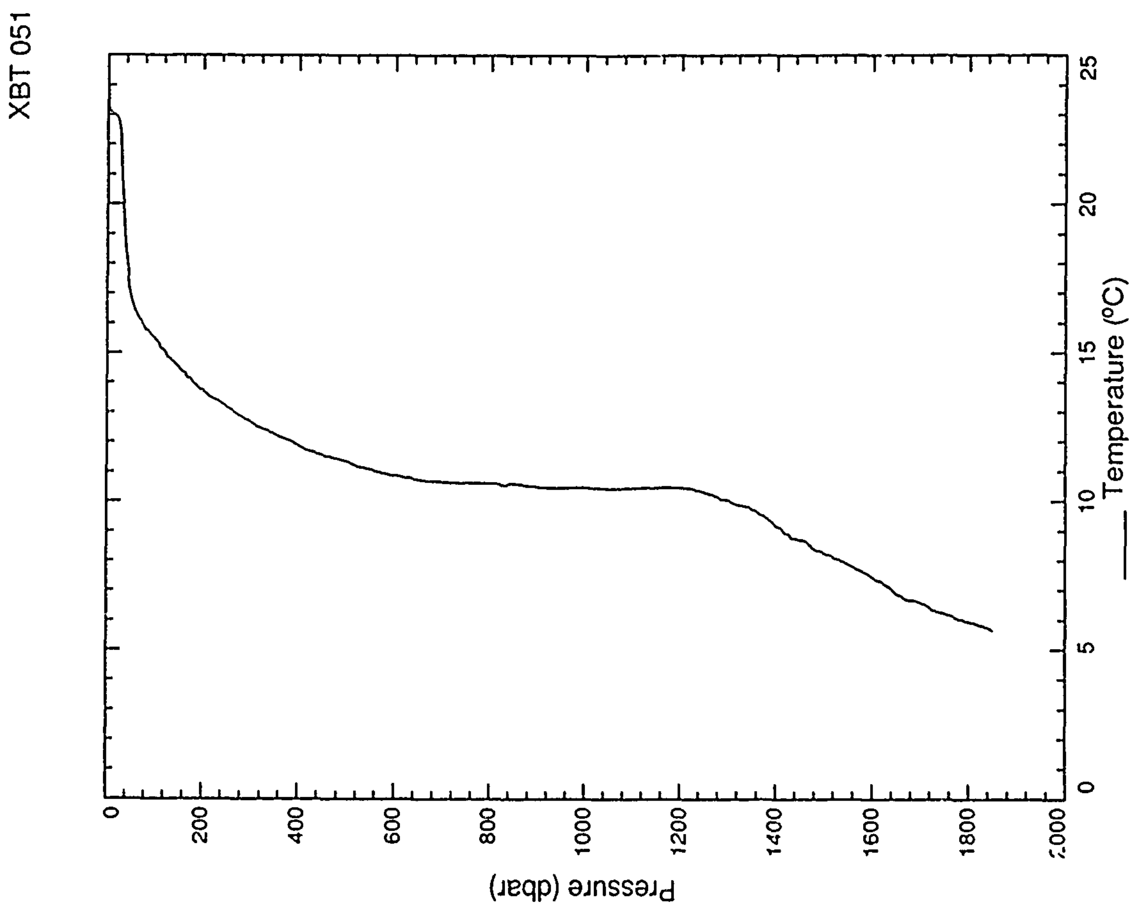
20
25


XBT 051
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1400
1600
1800
Temperature (ºC)
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10
15
20
25

XBTs 053–057

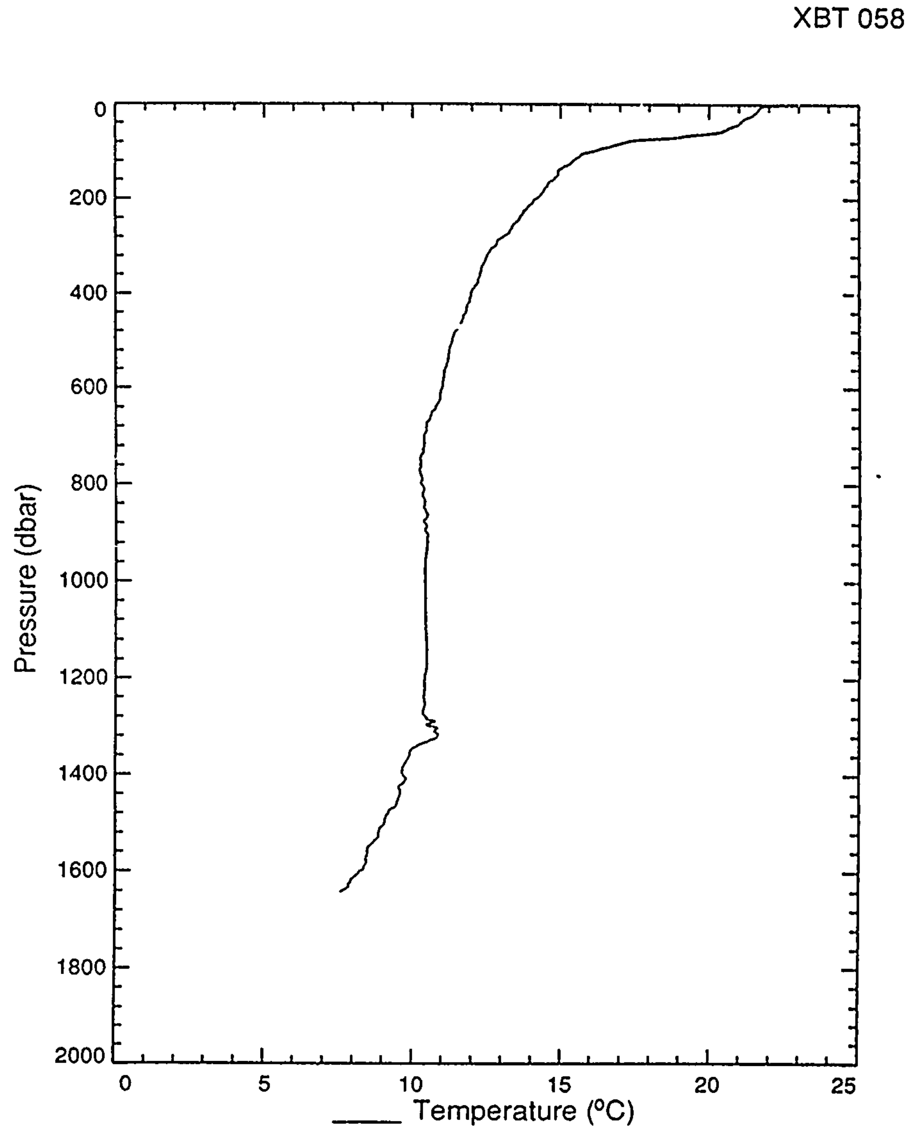
No File Created

Bad Data

On Backup Tape Only

Bad Data

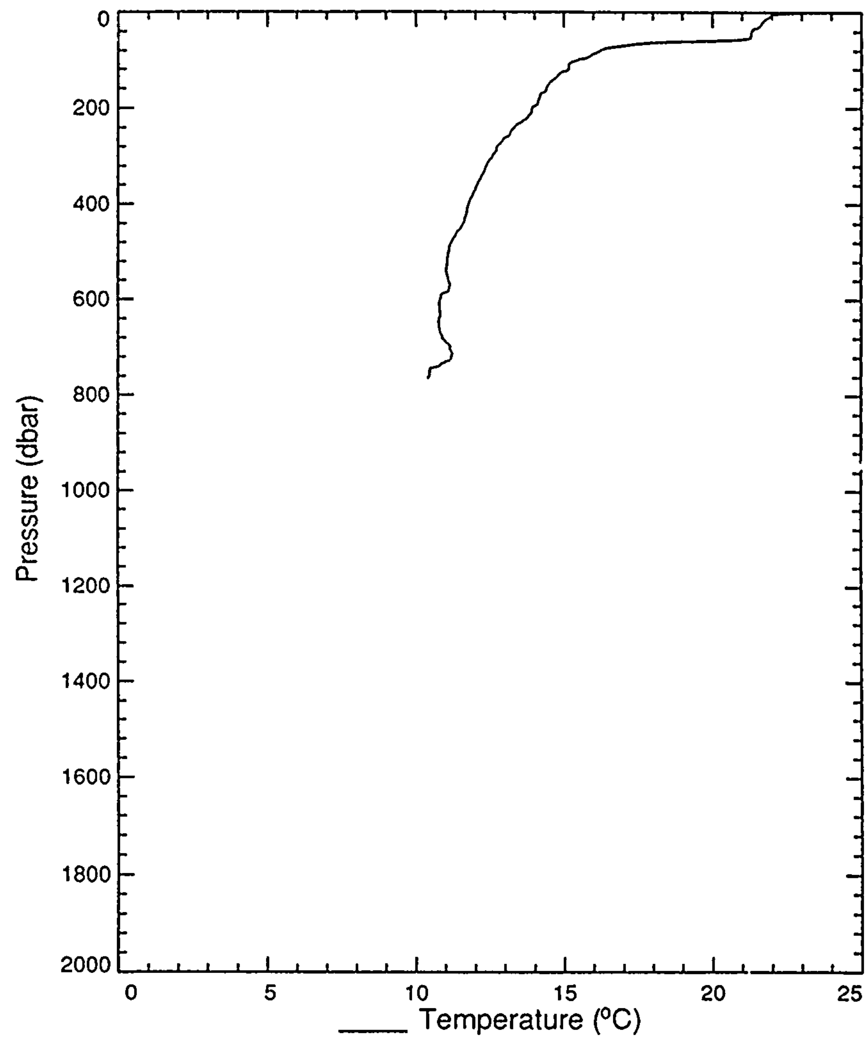
Off Scale



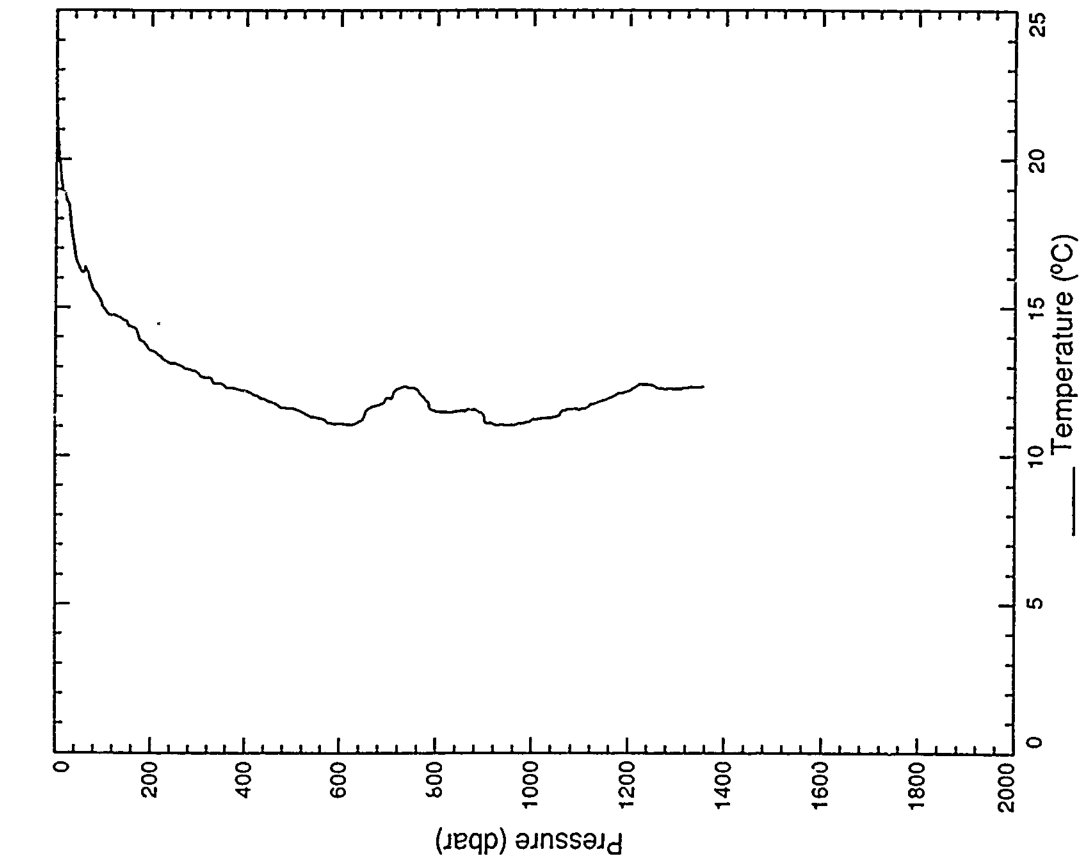
XBT 059

Bad Data

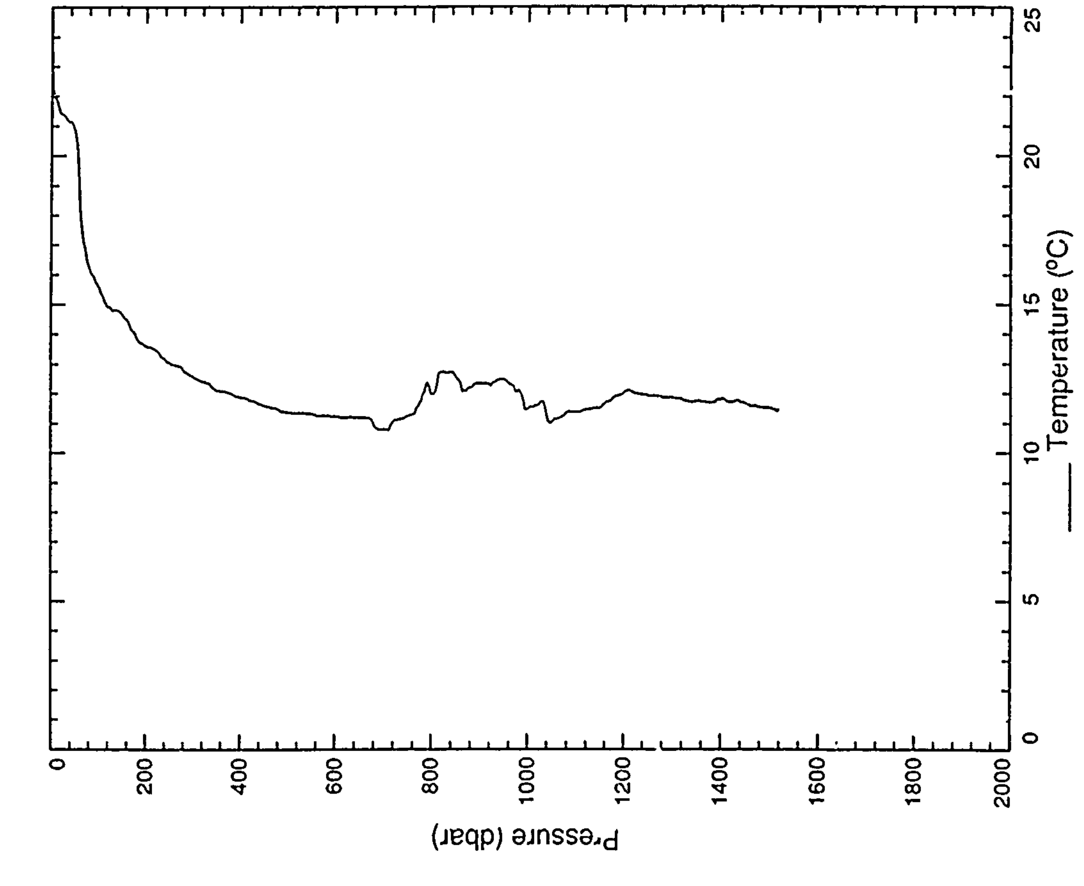
XBT 060

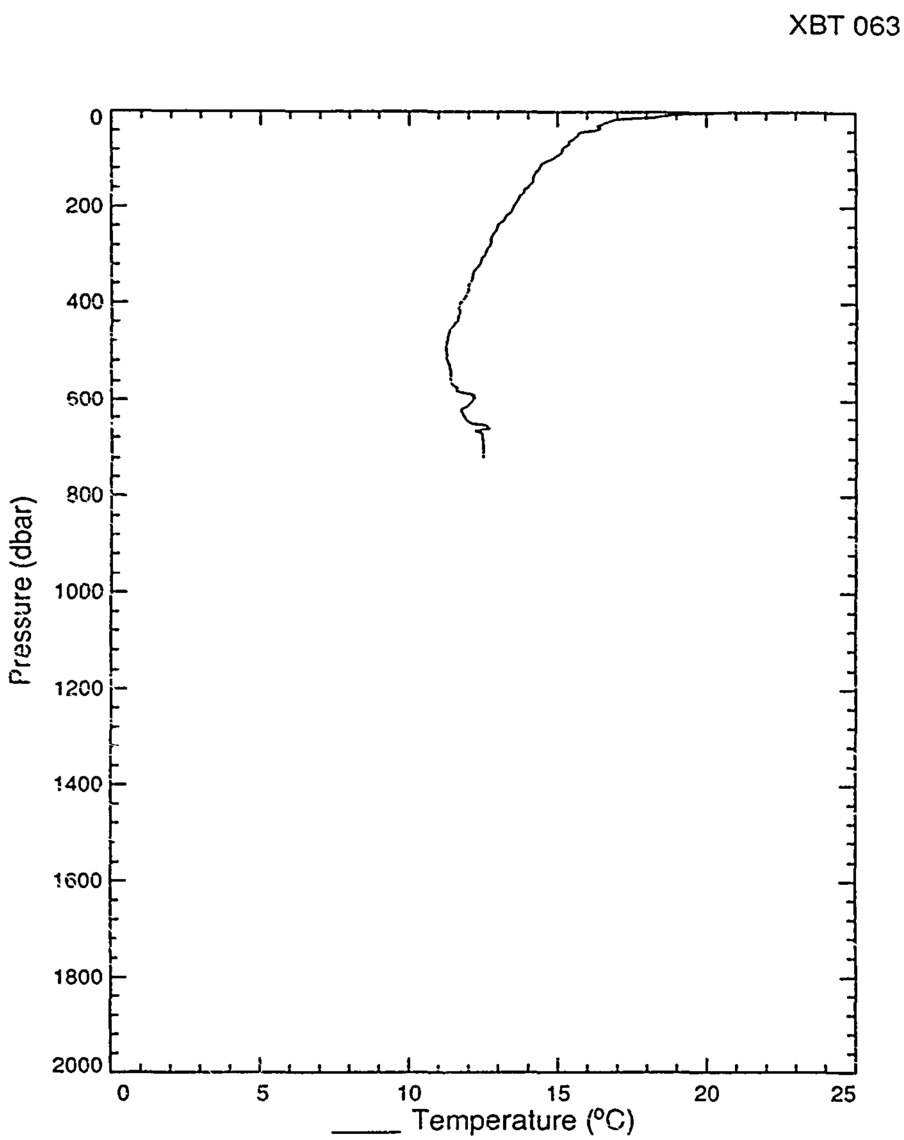


XBT 062



XBT 061




XBT 063
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Pressure (dbar)
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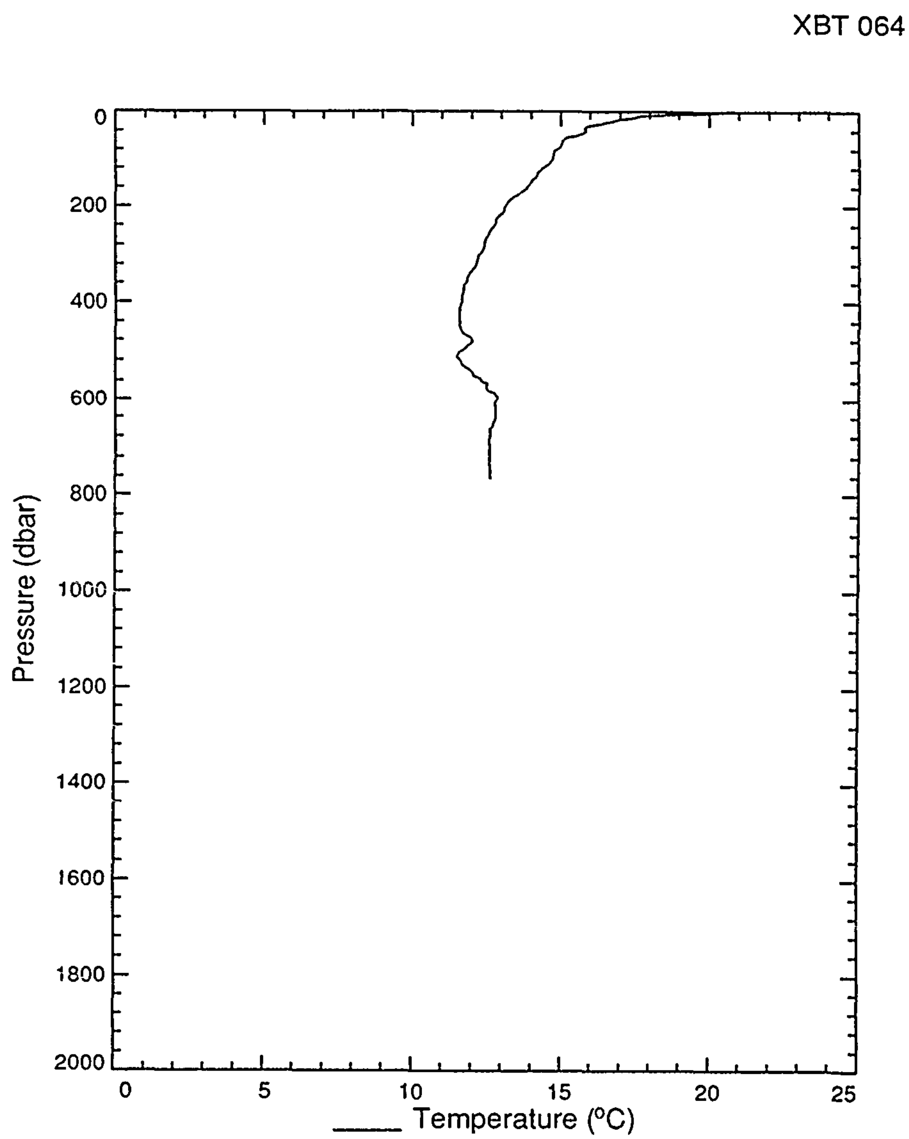
20
25
Temperature (°C)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1800
2000
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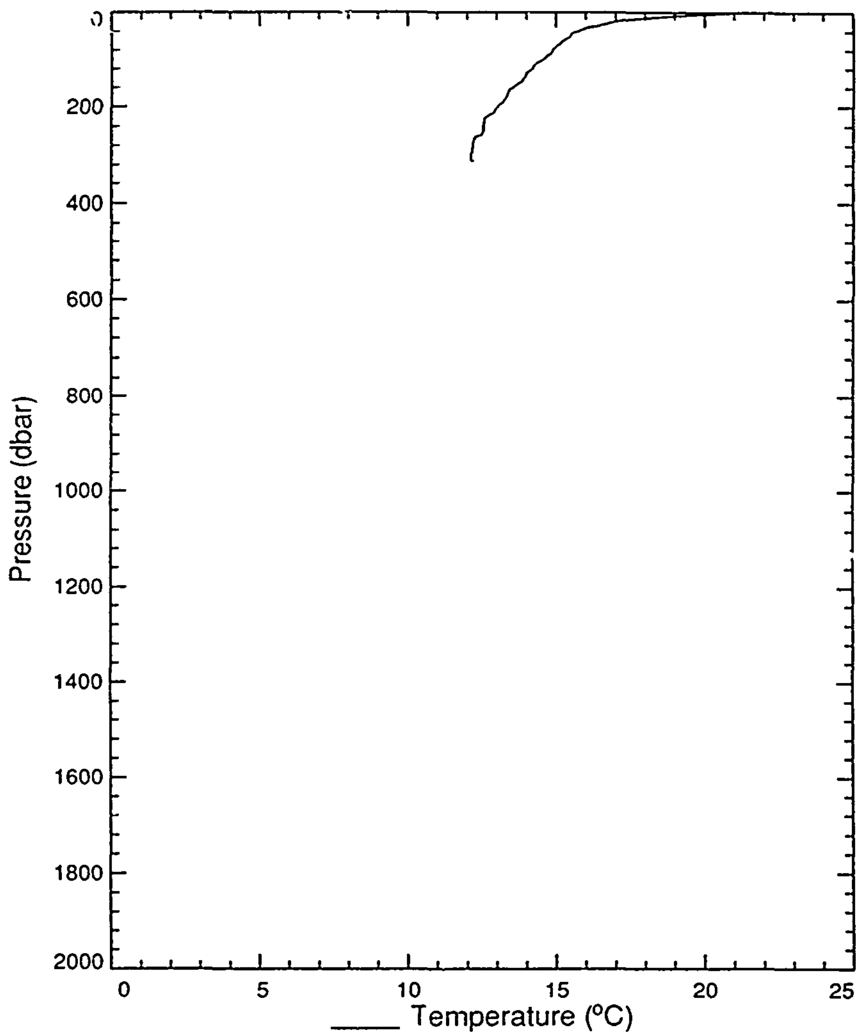
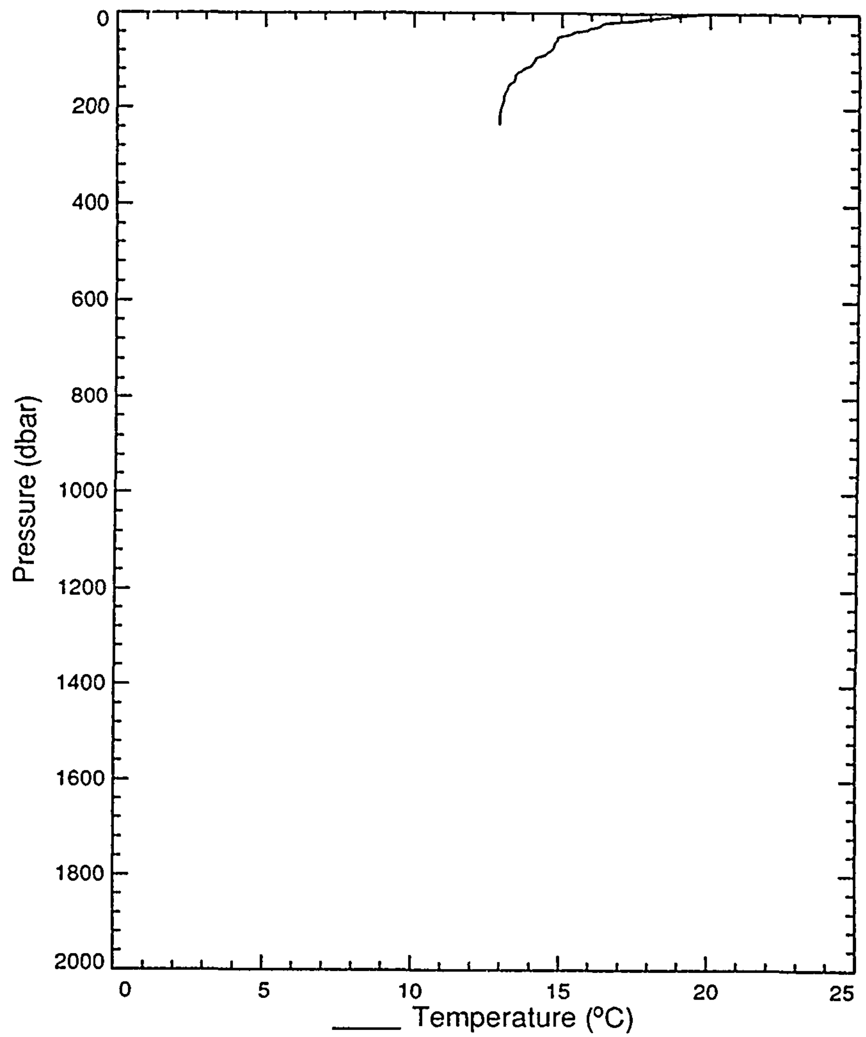
10
15
20
25
Temperature (°C)

XBT 065



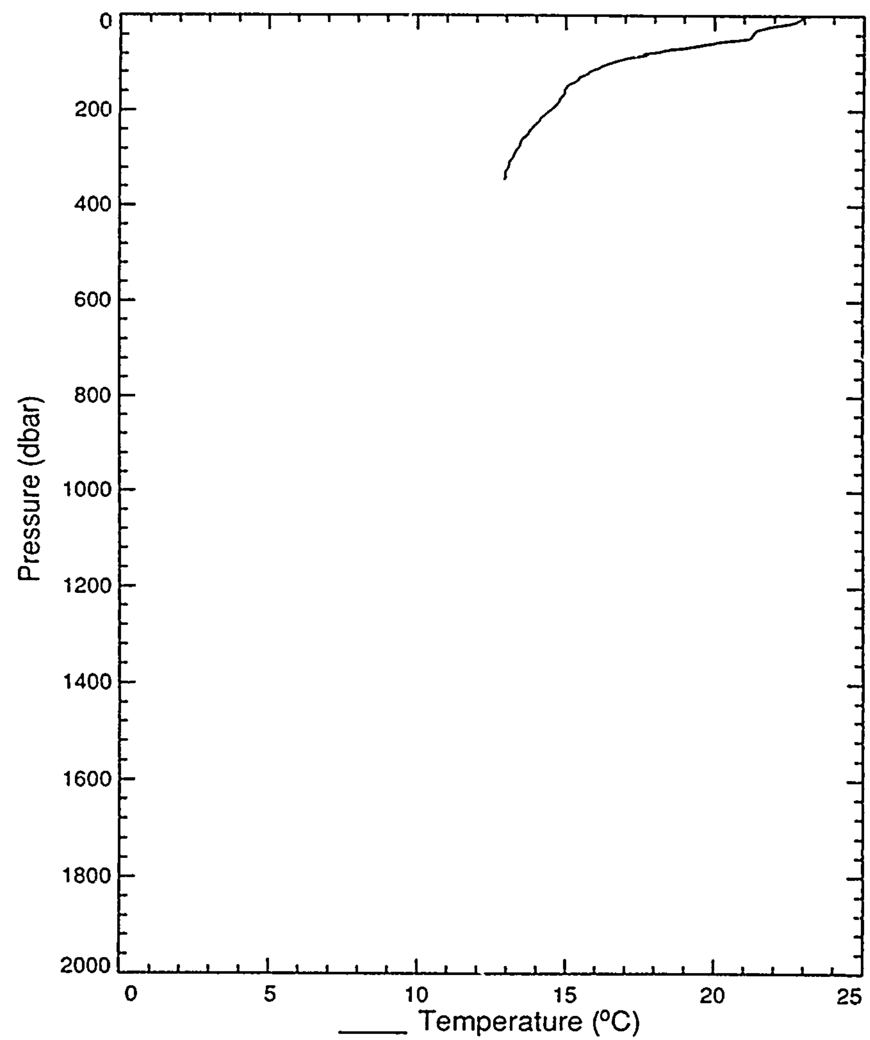
XBT 066

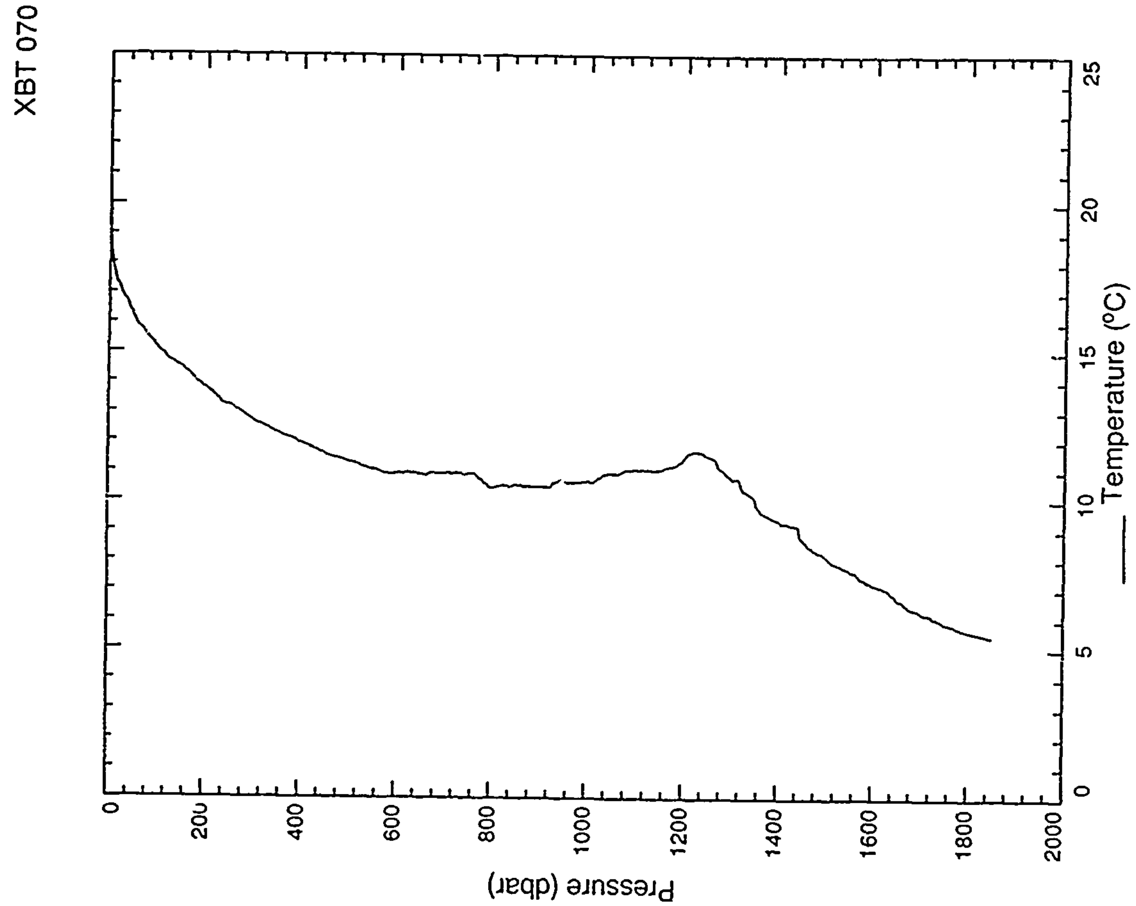


XBT 067

Bad Data

XBT 068




XBT 070
Pressure (dbar)
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1800
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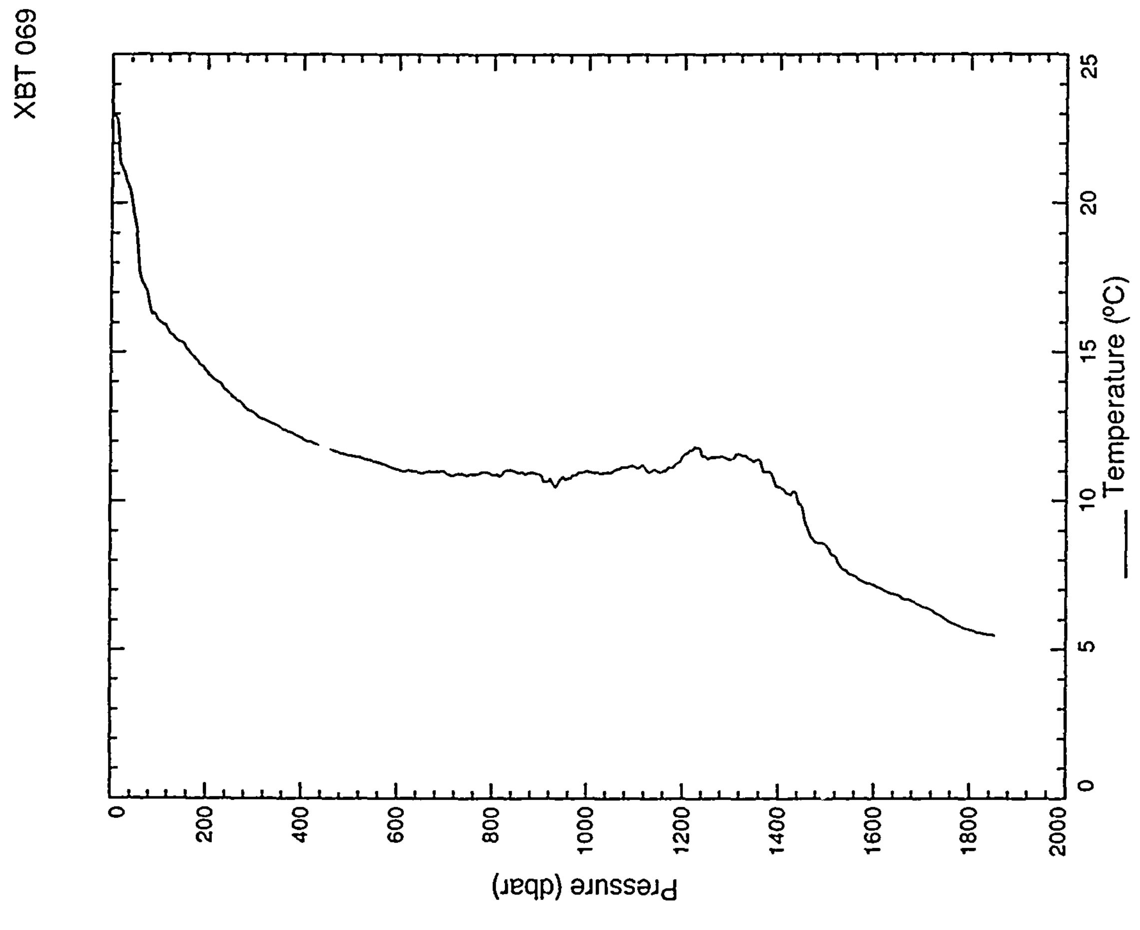
15
20
25
Temperature (ºC)


XBT 069
Pressure (dbar)
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1800
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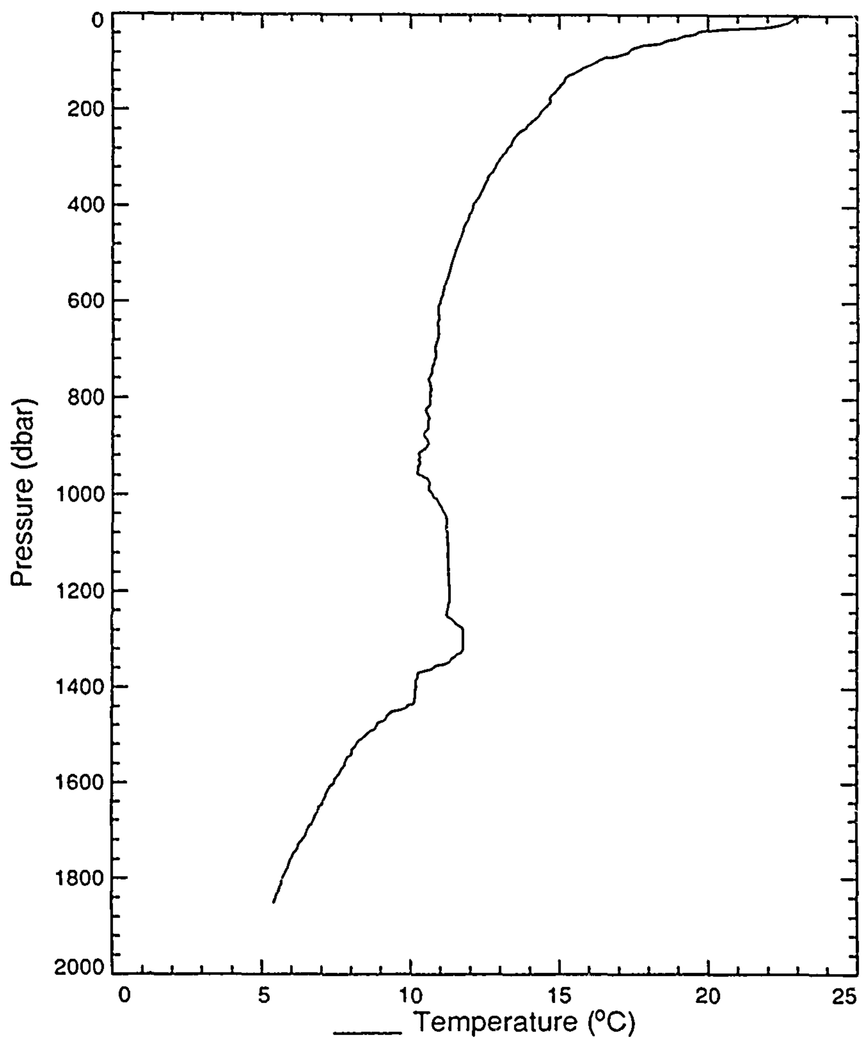
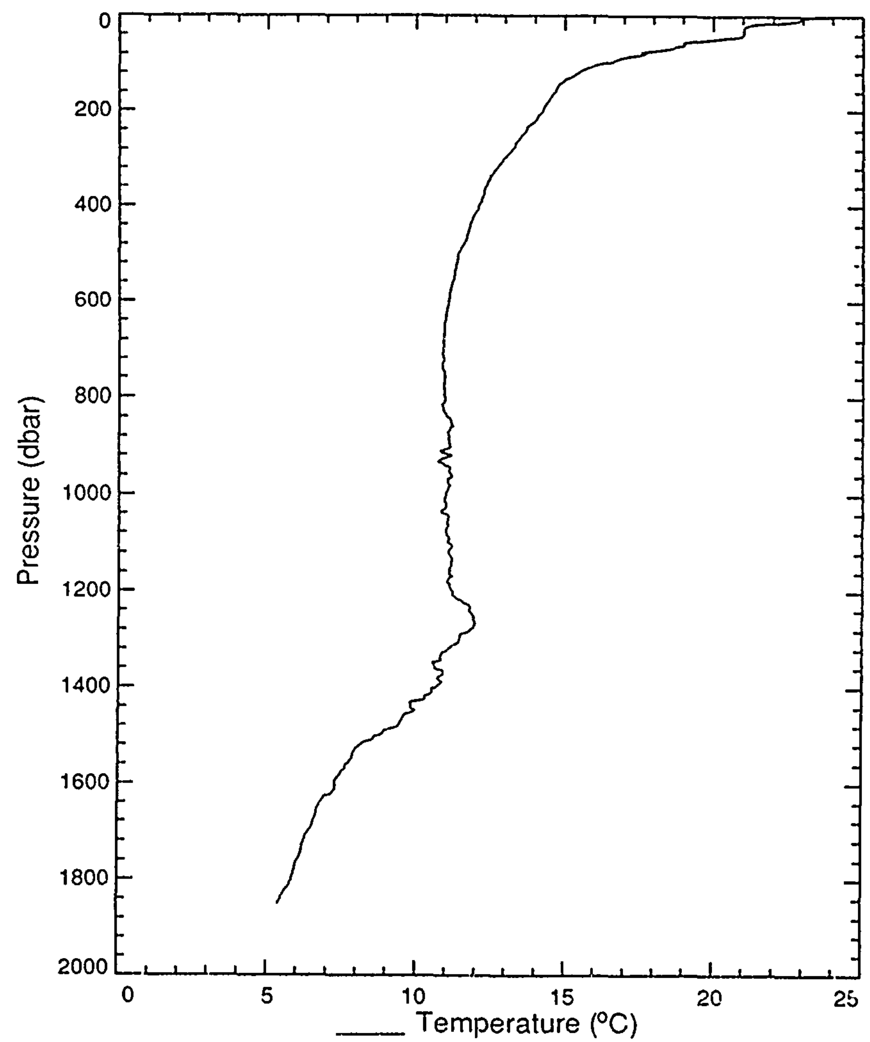
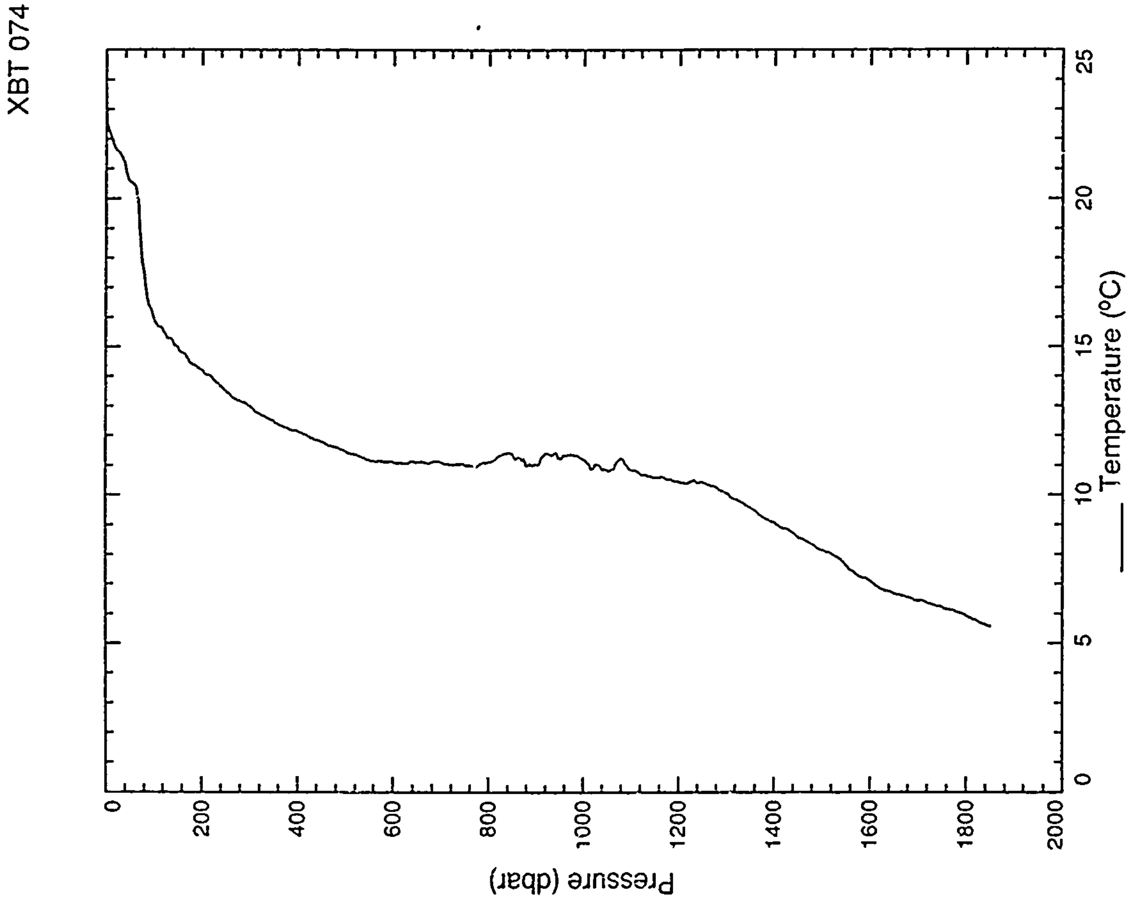
10
15
20
25
Temperature (ºC)

XBT 071



XBT 072




XBT 074
Pressure (dbar)
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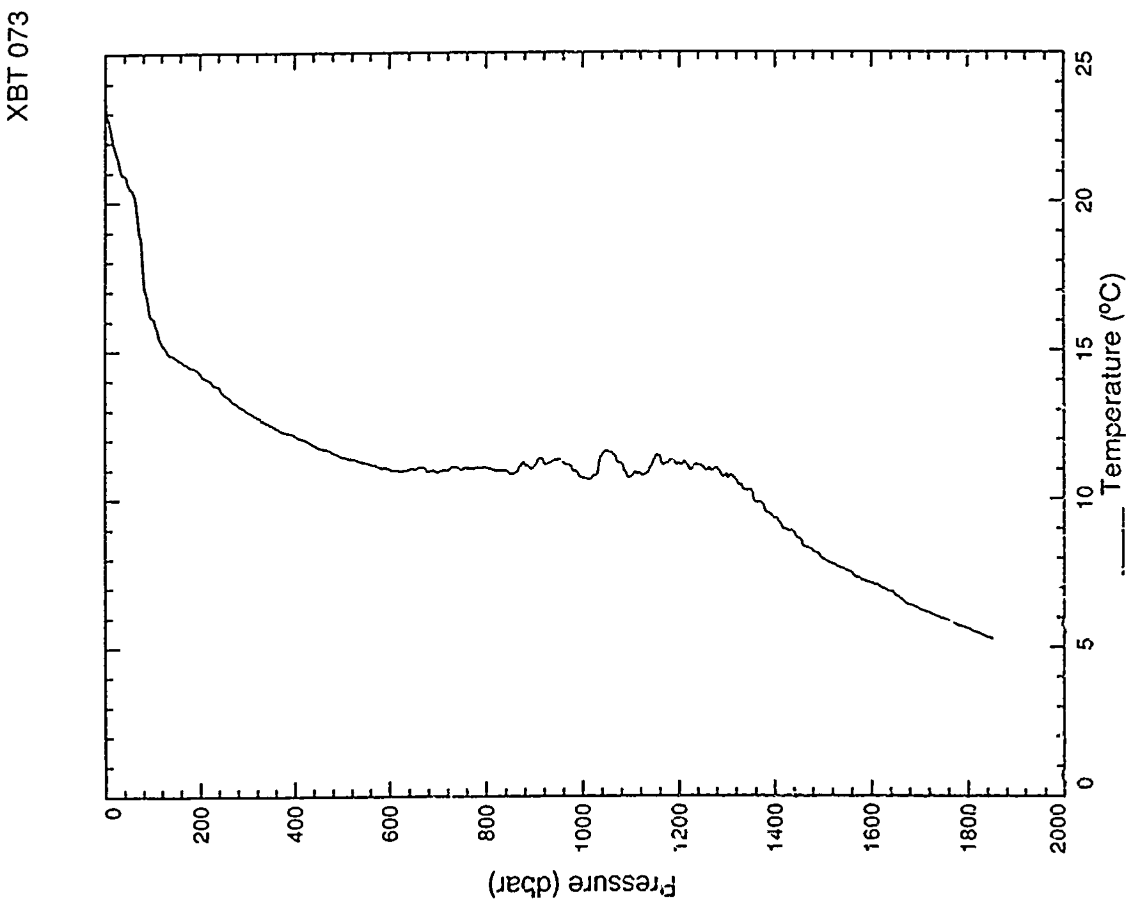
5
10
15
20
25
Temperature (°C)


XBT 073
Pressure (dbar)
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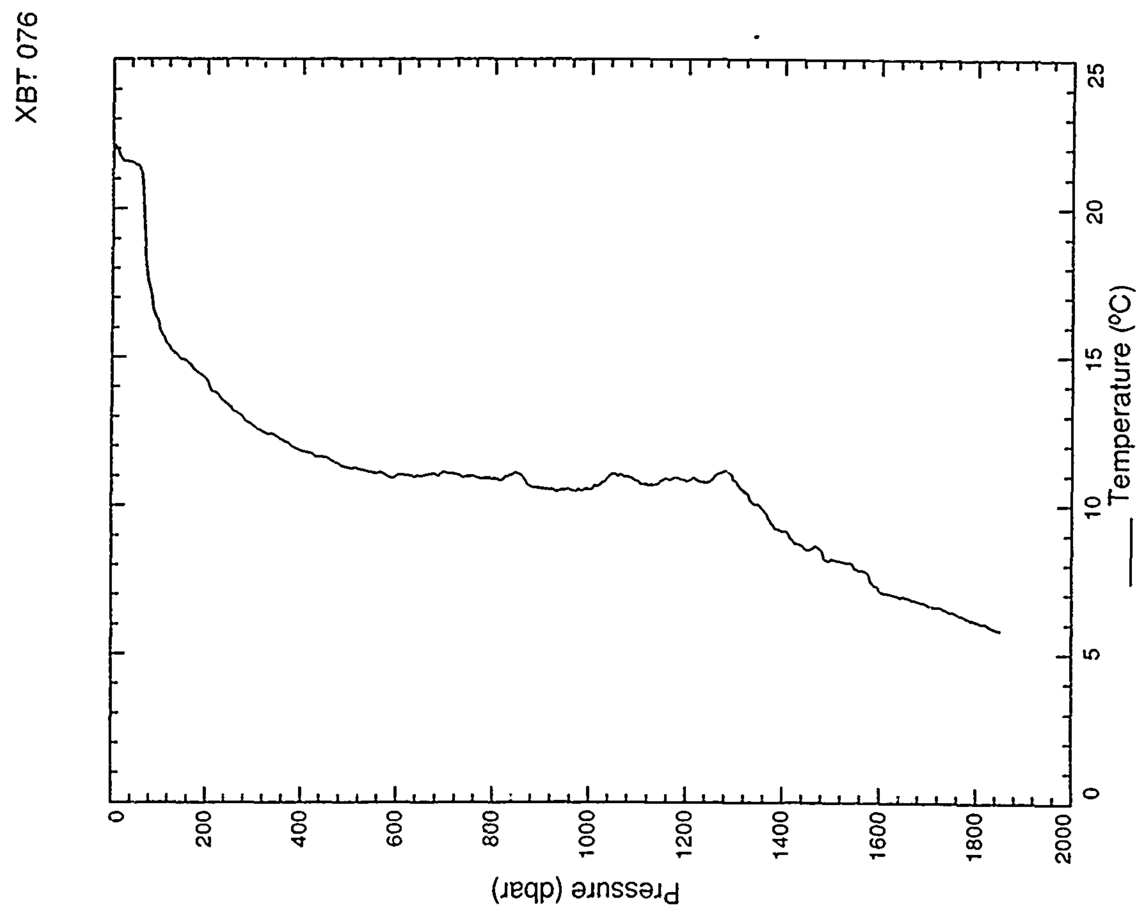
10
15
20
25
Temperature (°C)


XBT 076
Pressure (dbar)
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2000
Temperature (ºC)
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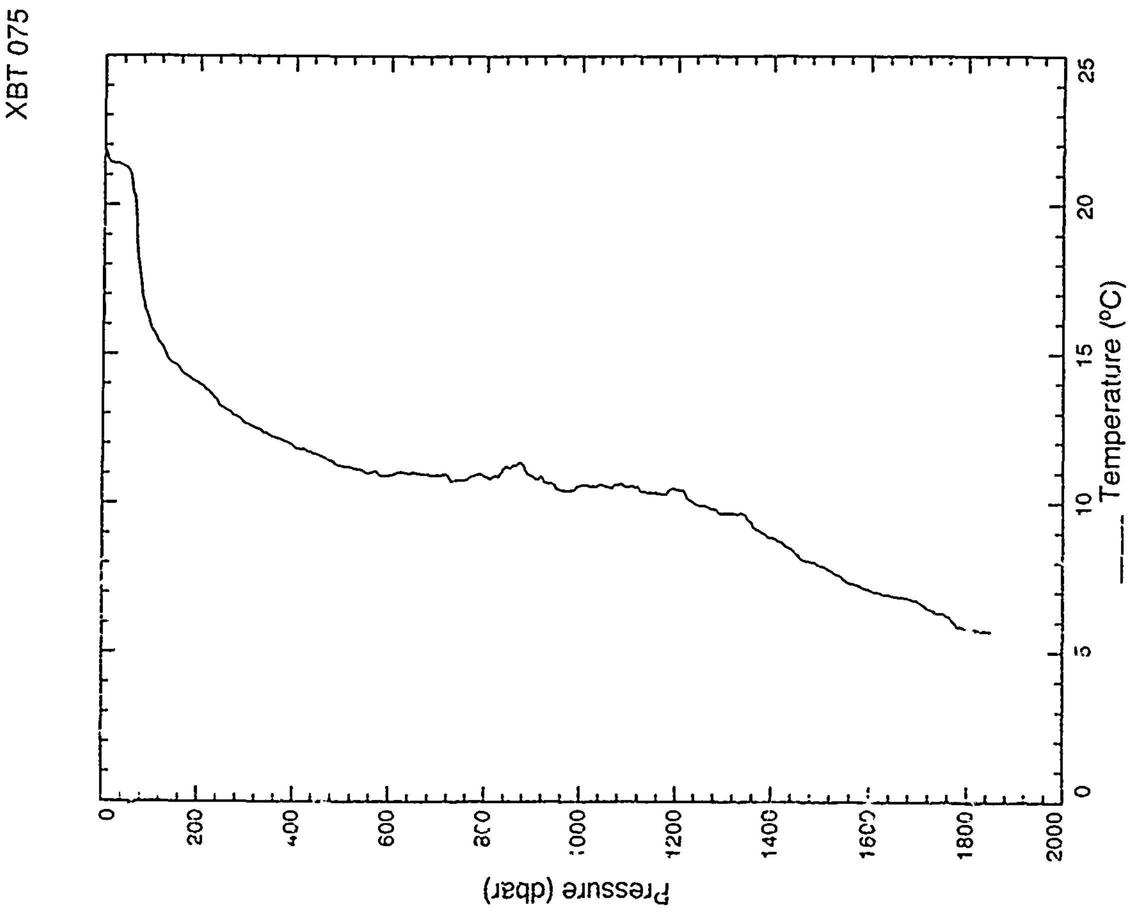
10
15
20
25


XBT 075
Pressure (dbar)
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1800
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Temperature (ºC)
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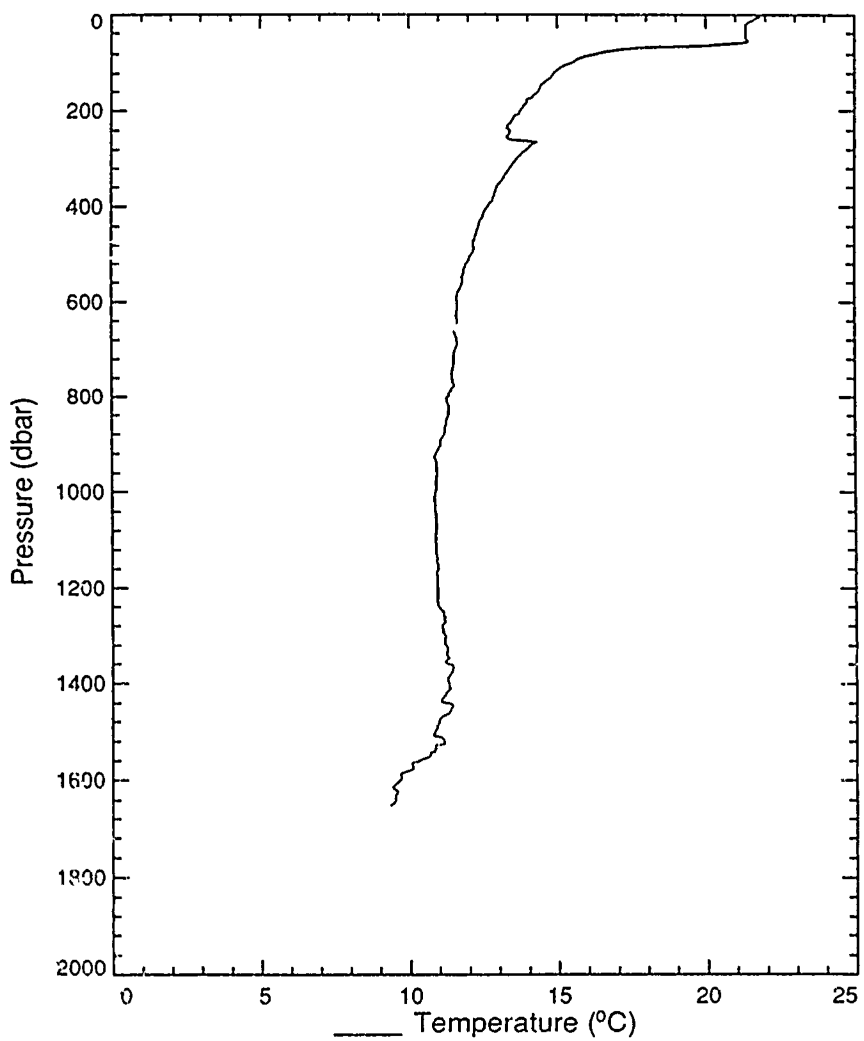
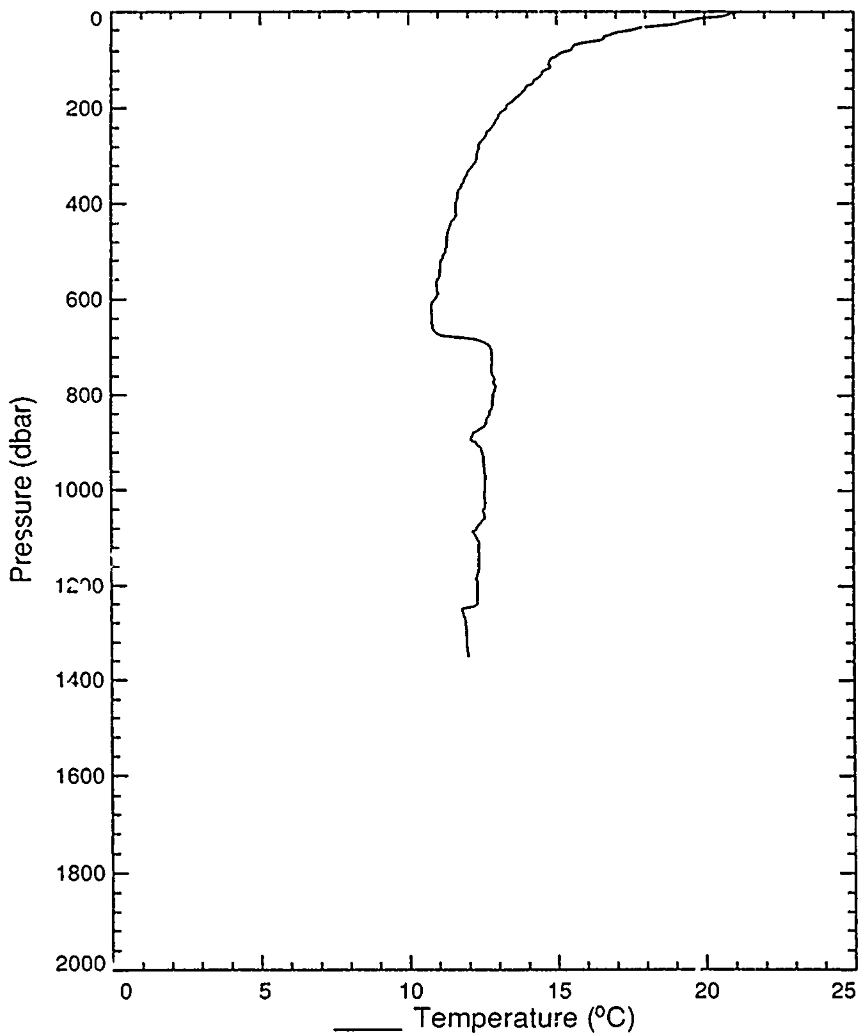
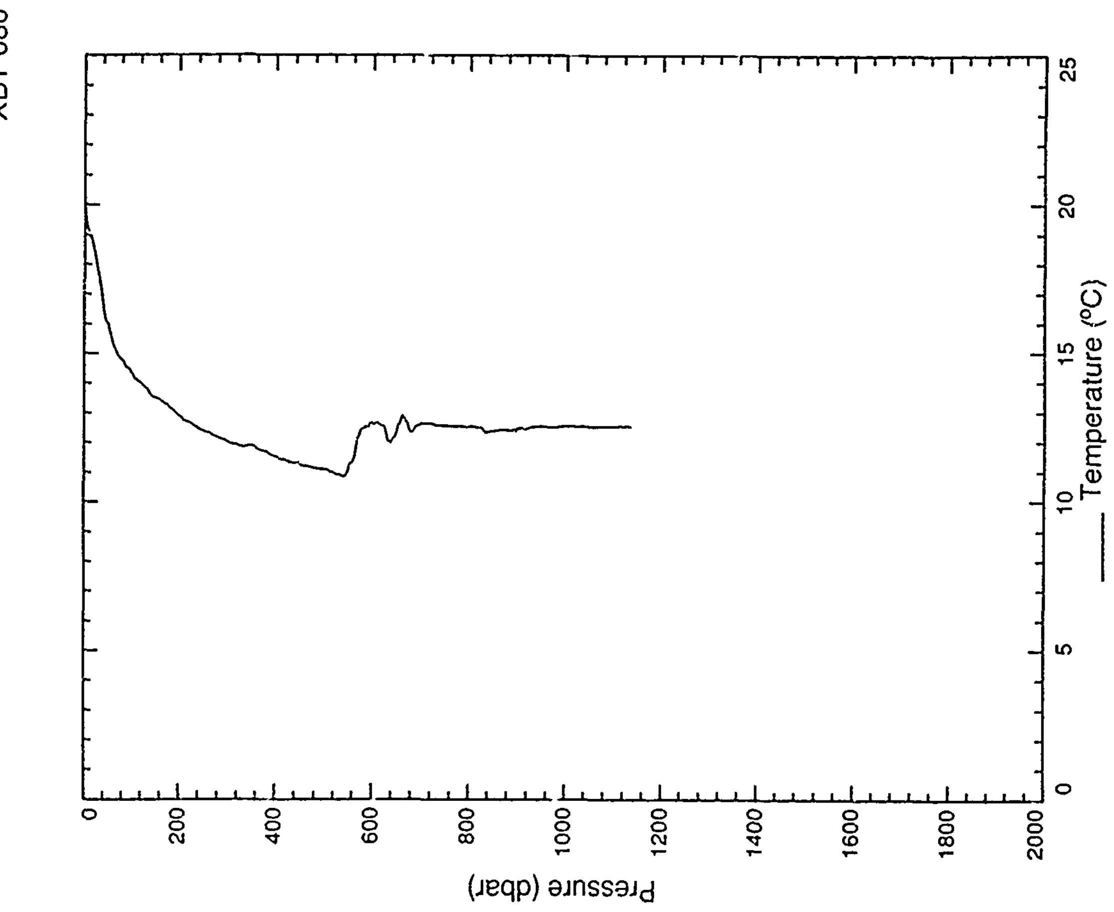
5
10
15
20
25

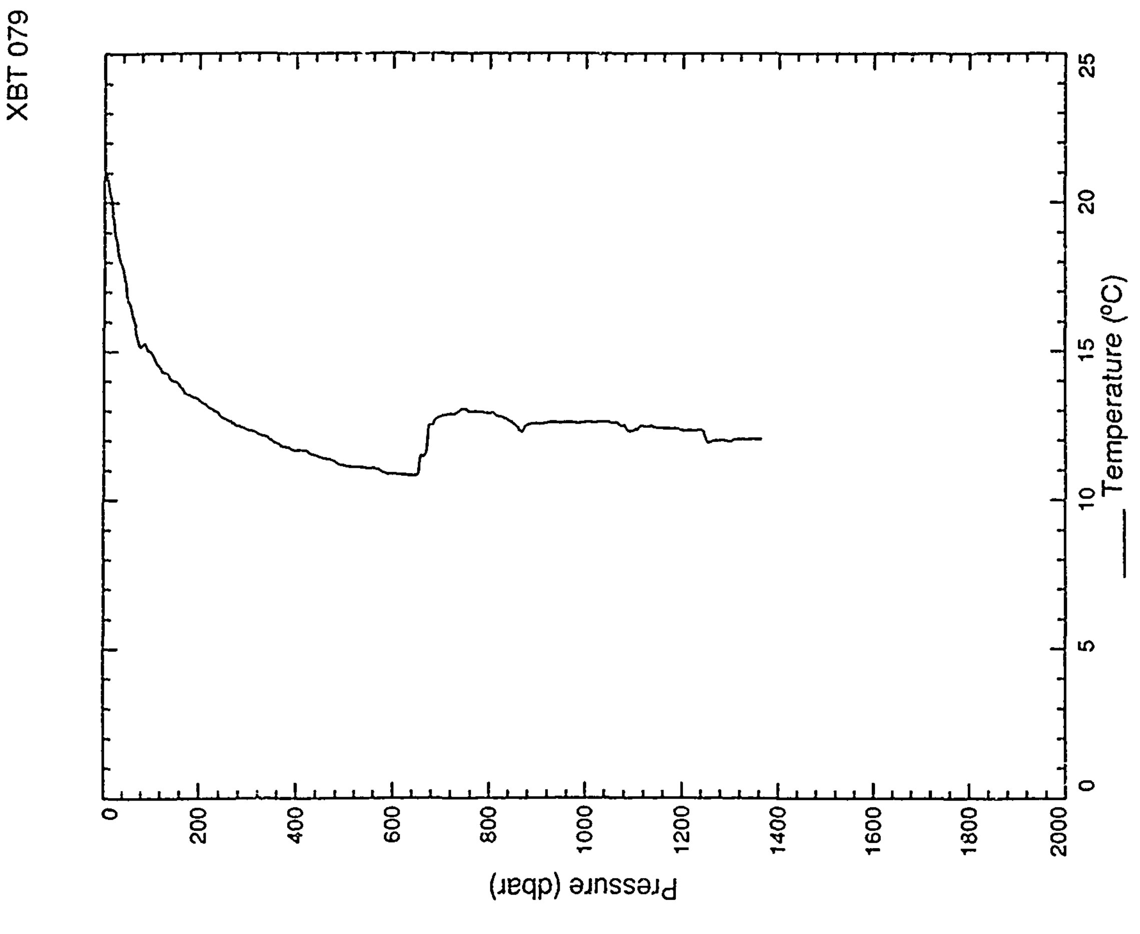
XBT 077

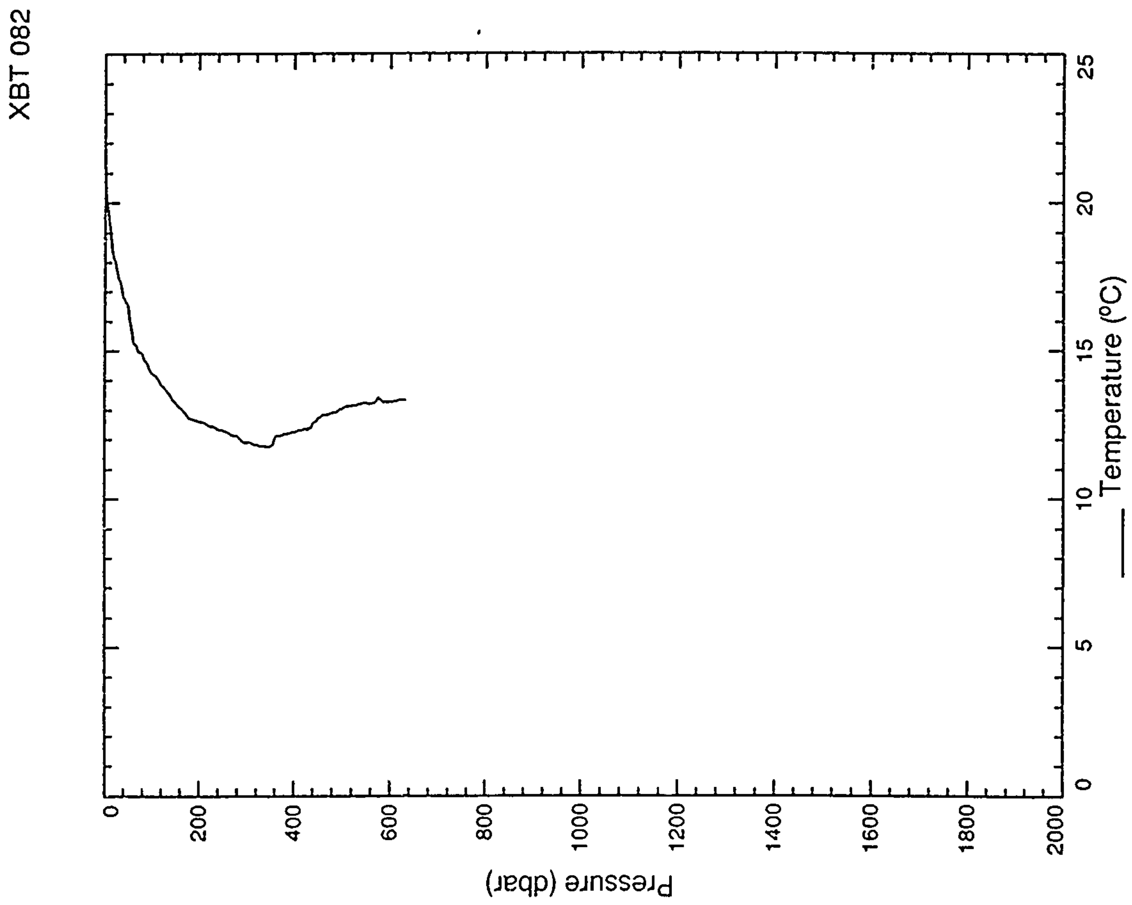


XBT 078




XBT 080
Pressure (dbar)
Temperature (ºC)


XBT 079
Pressure (dbar)
Temperature (ºC)


XBT 082
Pressure (dbar)
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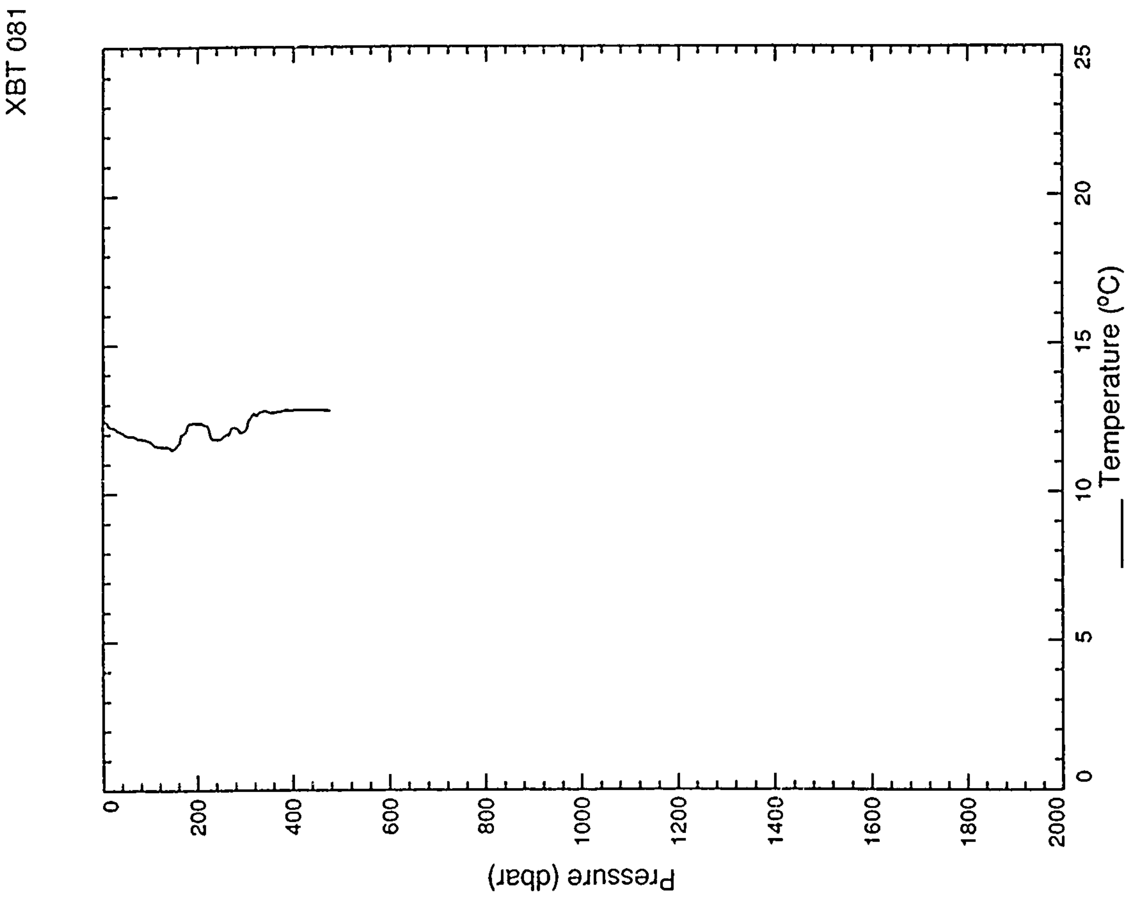
20
25
Temperature (ºC)


XBT 081
Pressure (dbar)
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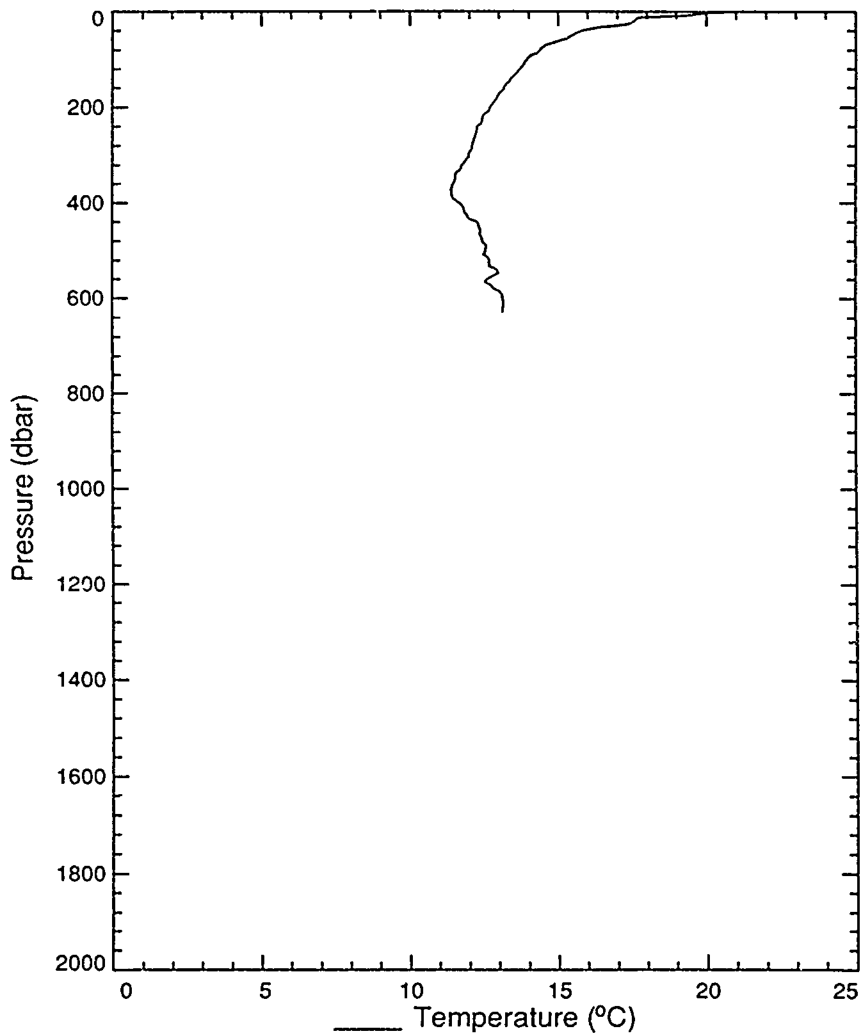
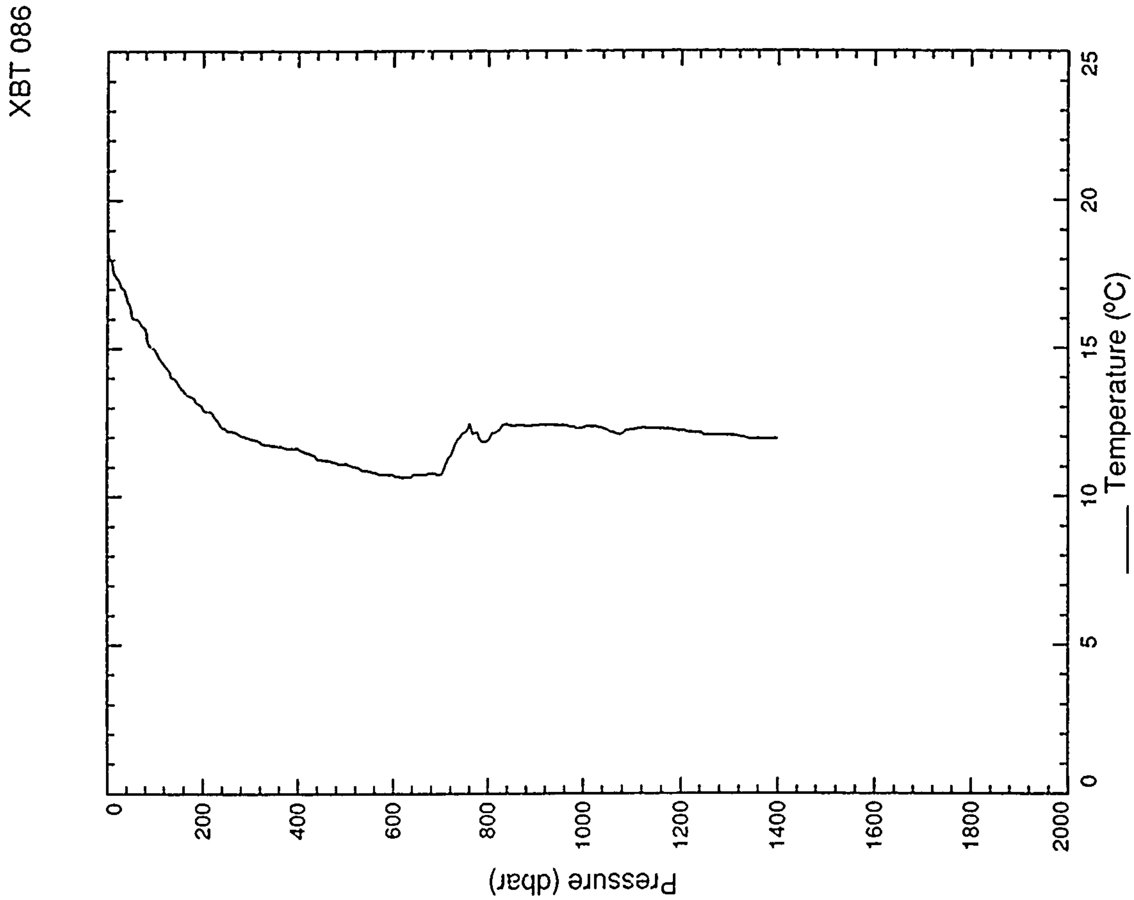
15
20
25
Temperature (ºC)

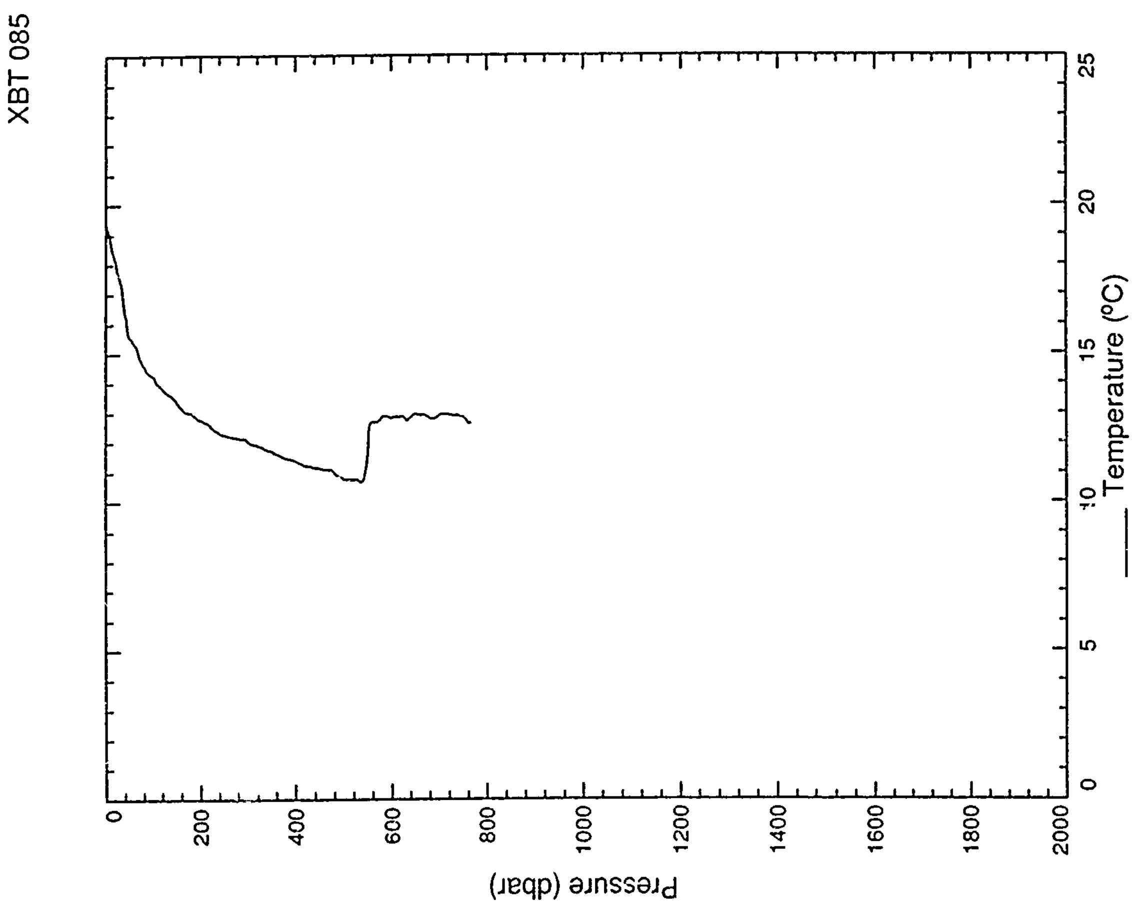
XBT 083

Off Scale

XBT 084



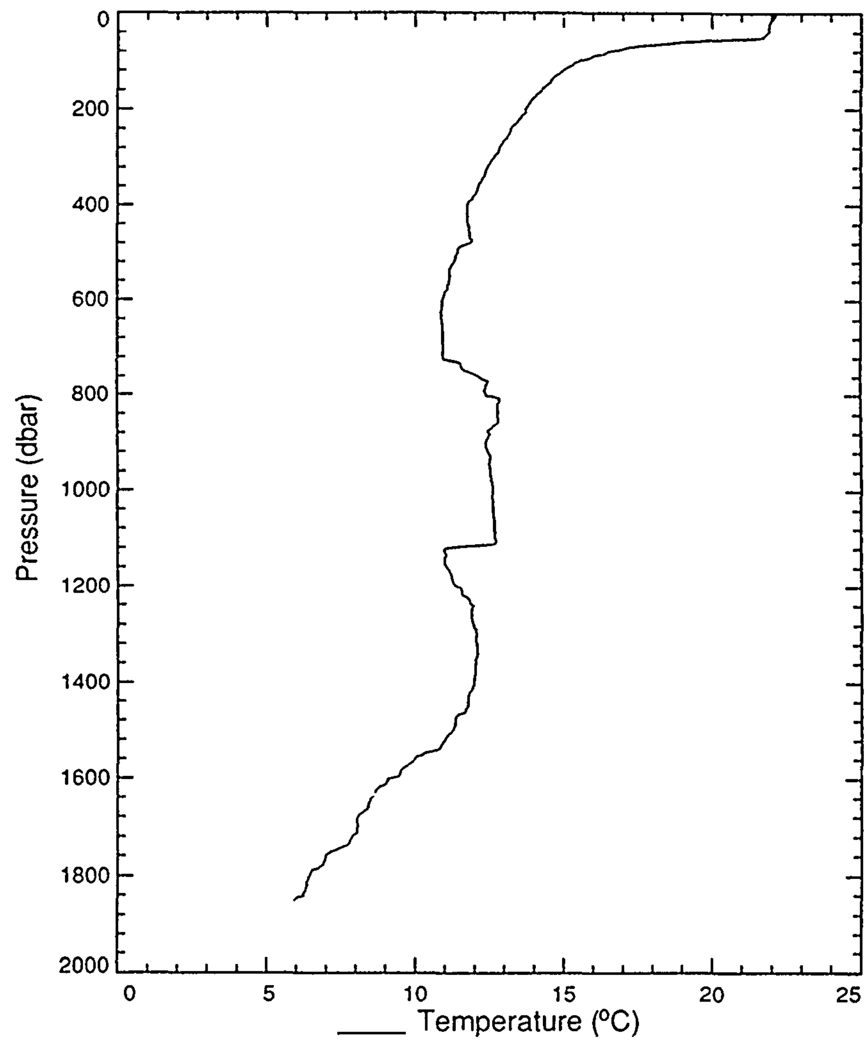

XBT 086
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

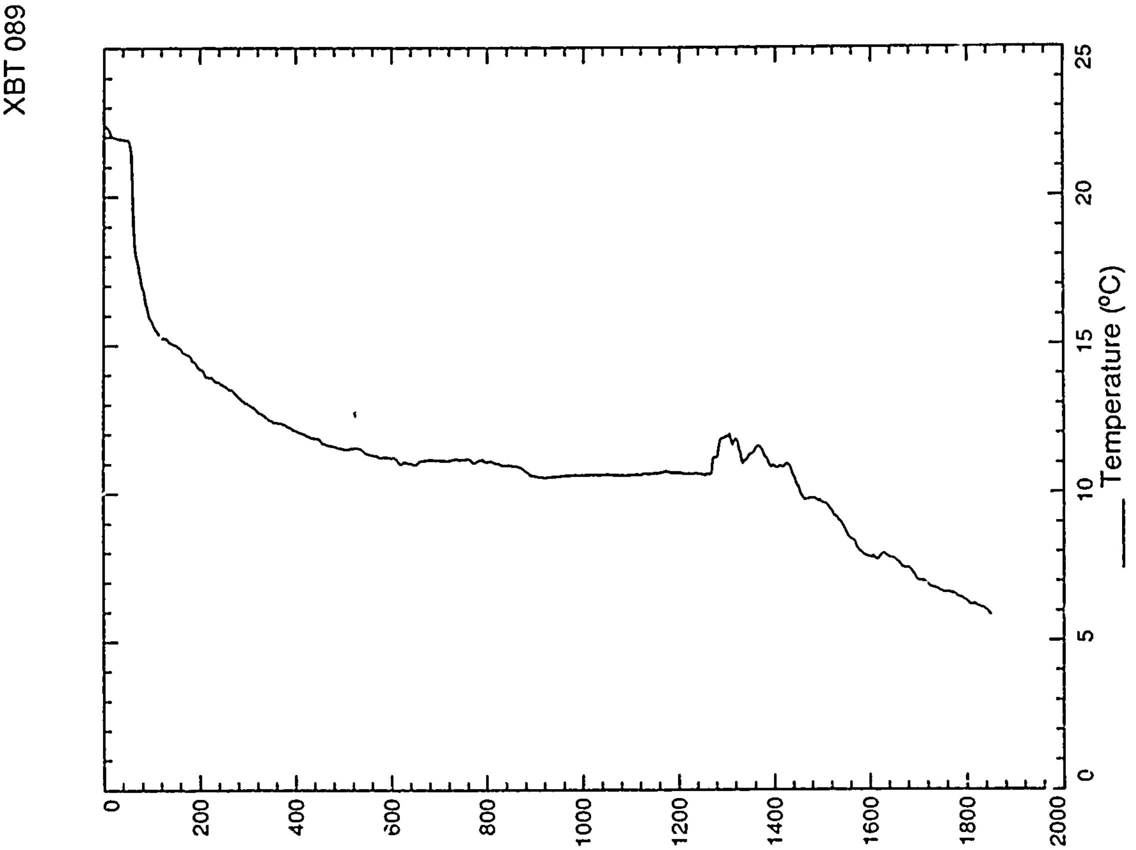

XBT 085
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

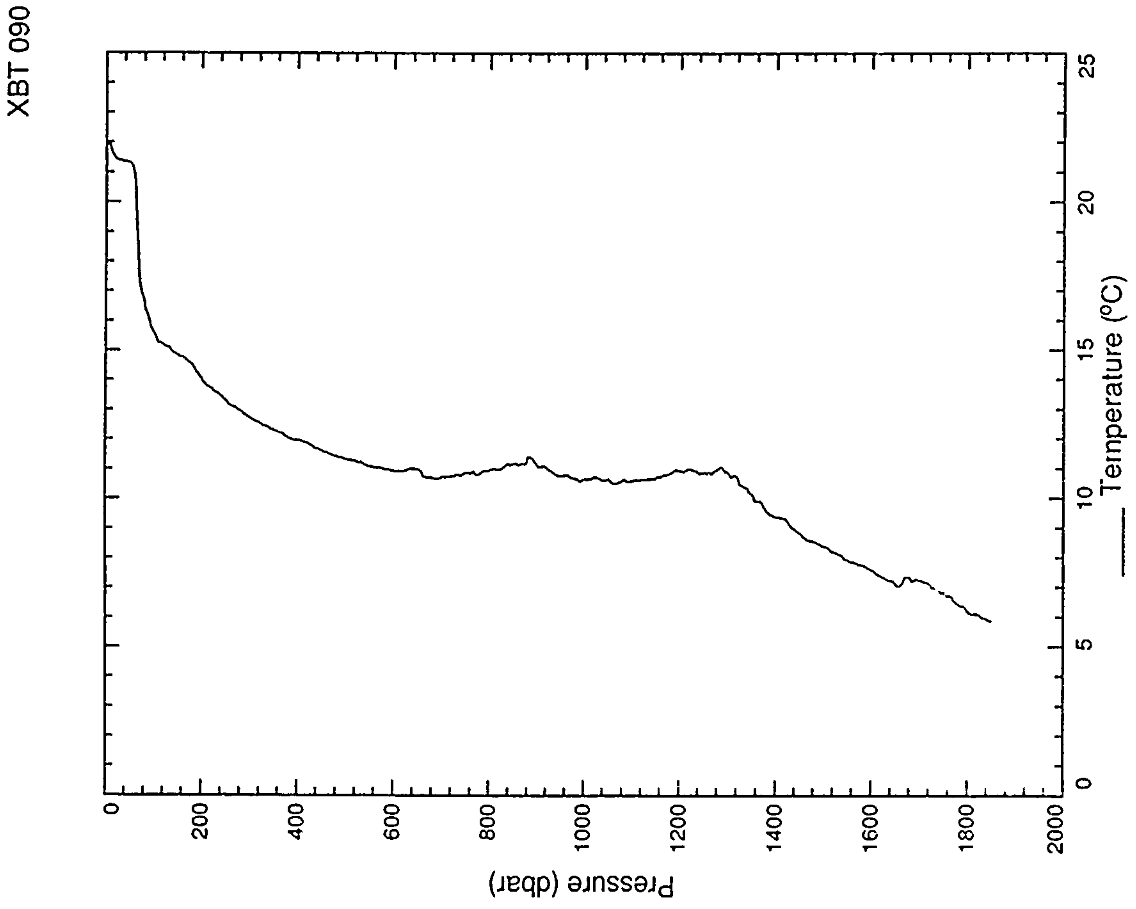
XBT 087

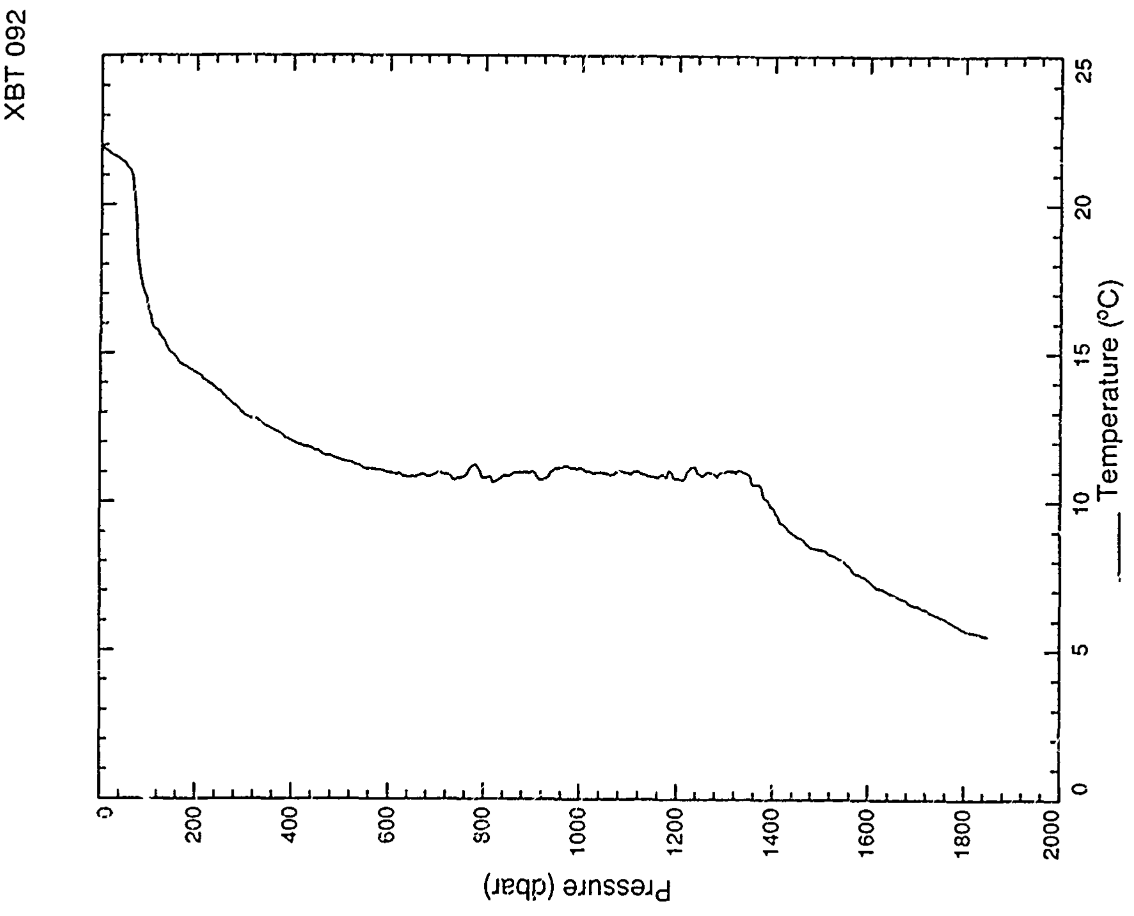
Off Scale

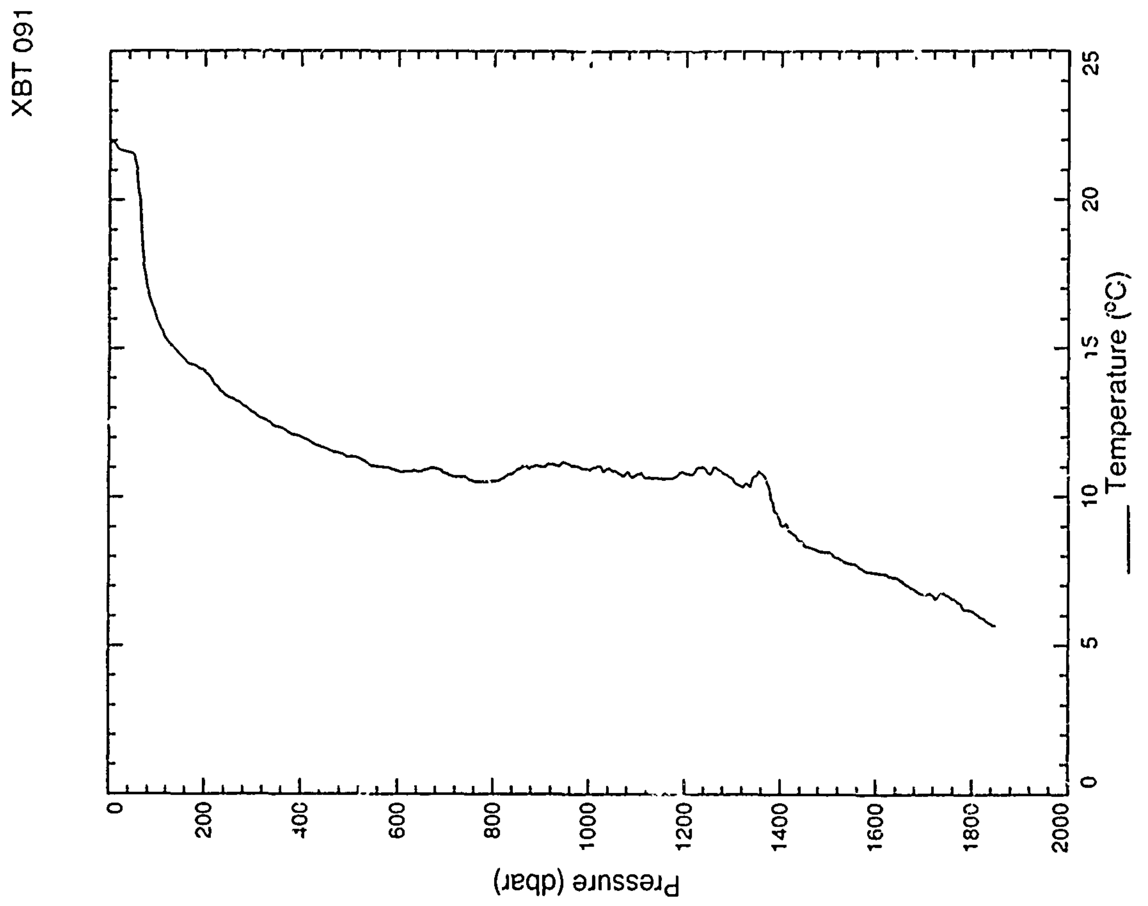
XBT 088

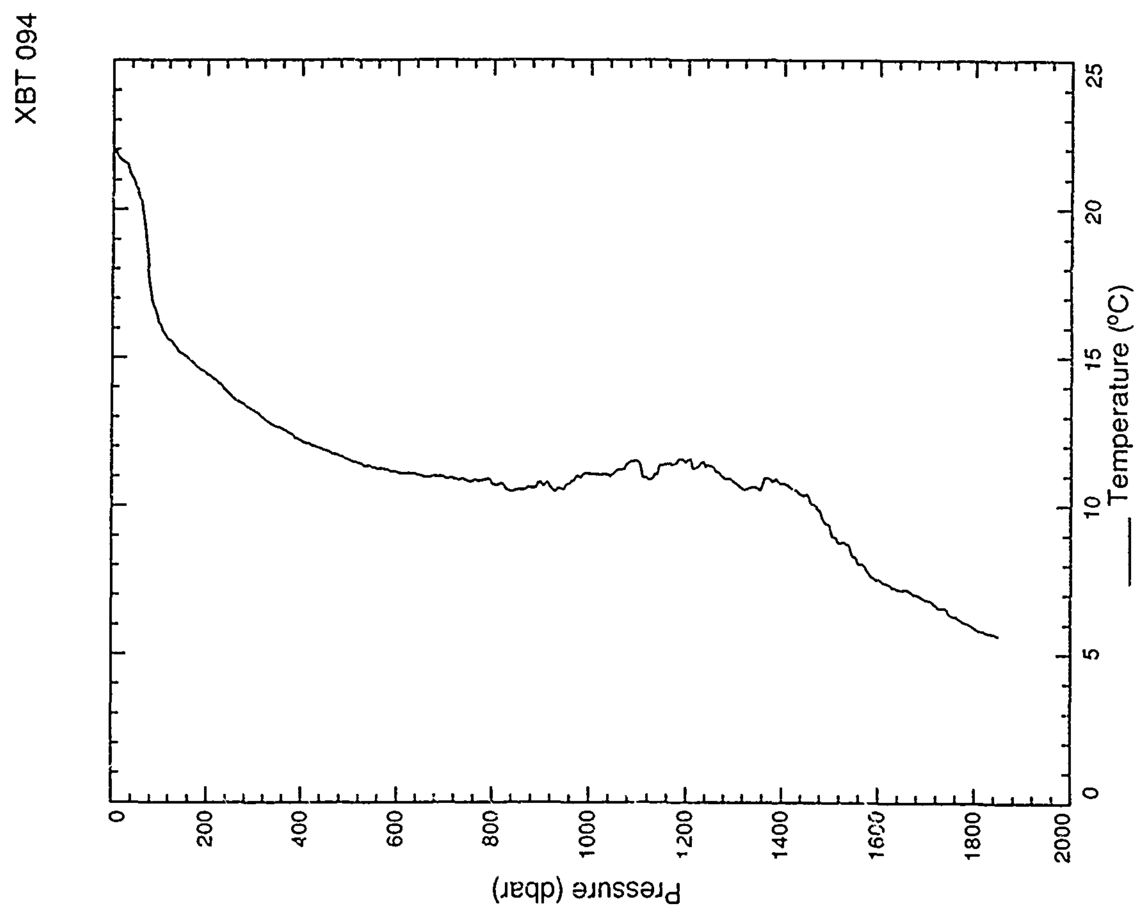


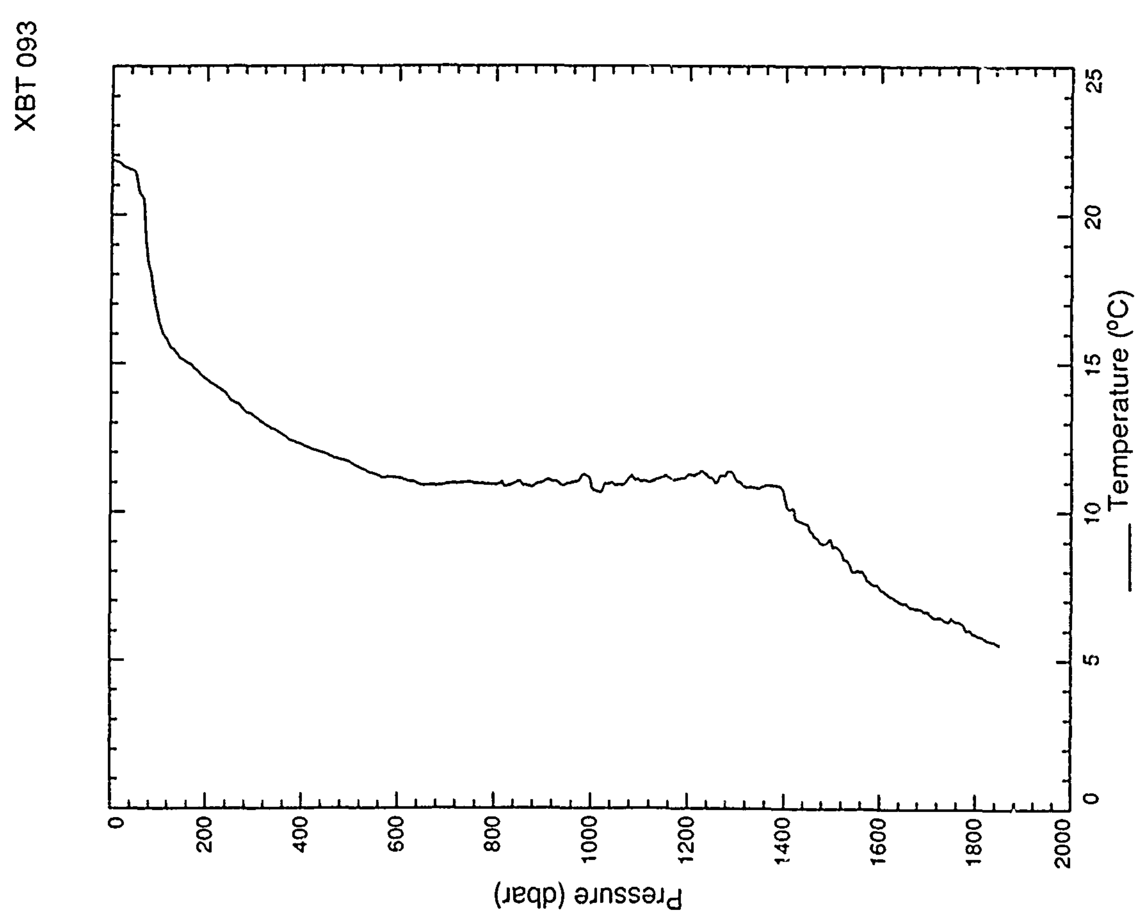

XBT 089
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

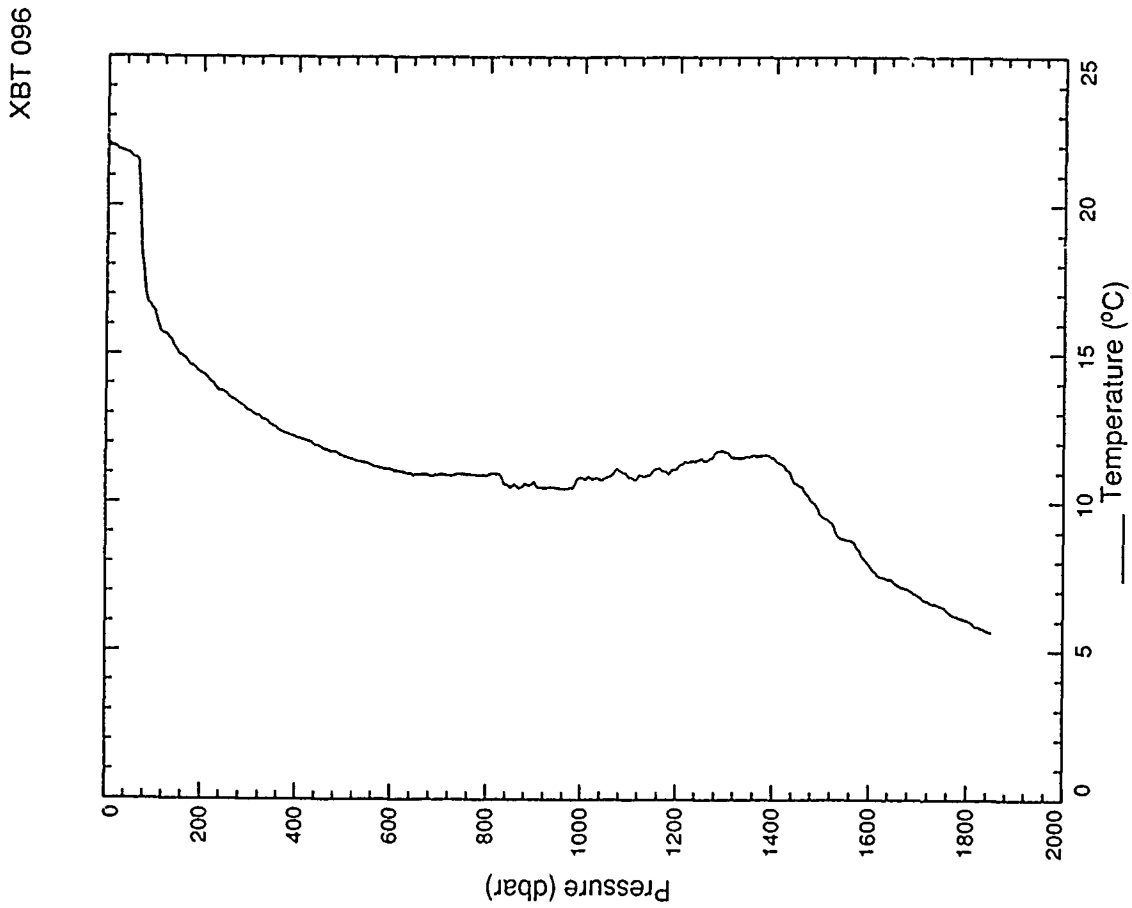

XBT 090
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

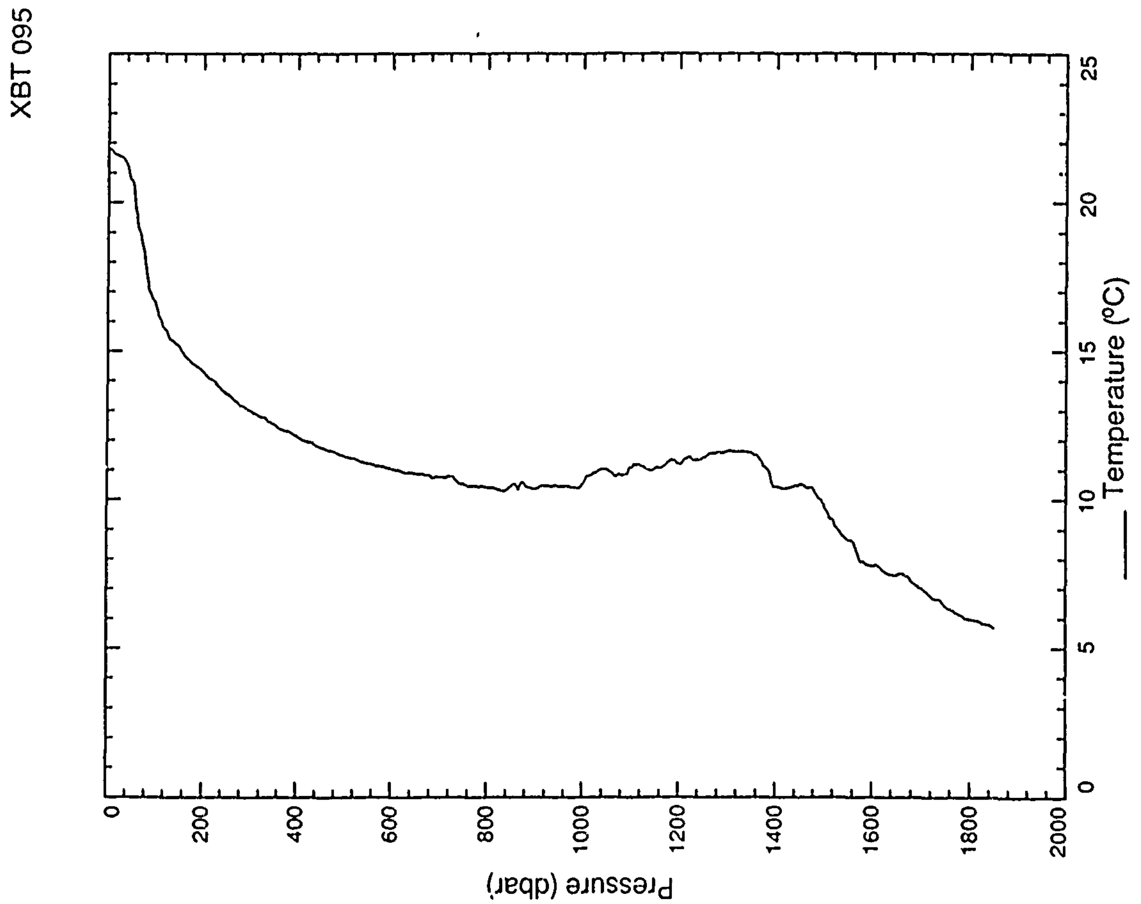

XBT 092
Temperature (°C)
Pressure (dbar)
0
5
10
15
20
25
0
200
400
600
800
1000
1200
1400
1600
1800
2000


XBT 091
Temperature (°C)
Pressure (dbar)
0
5
10
15
20
25
0
200
400
600
800
1000
1200
1400
1600
1800
2000

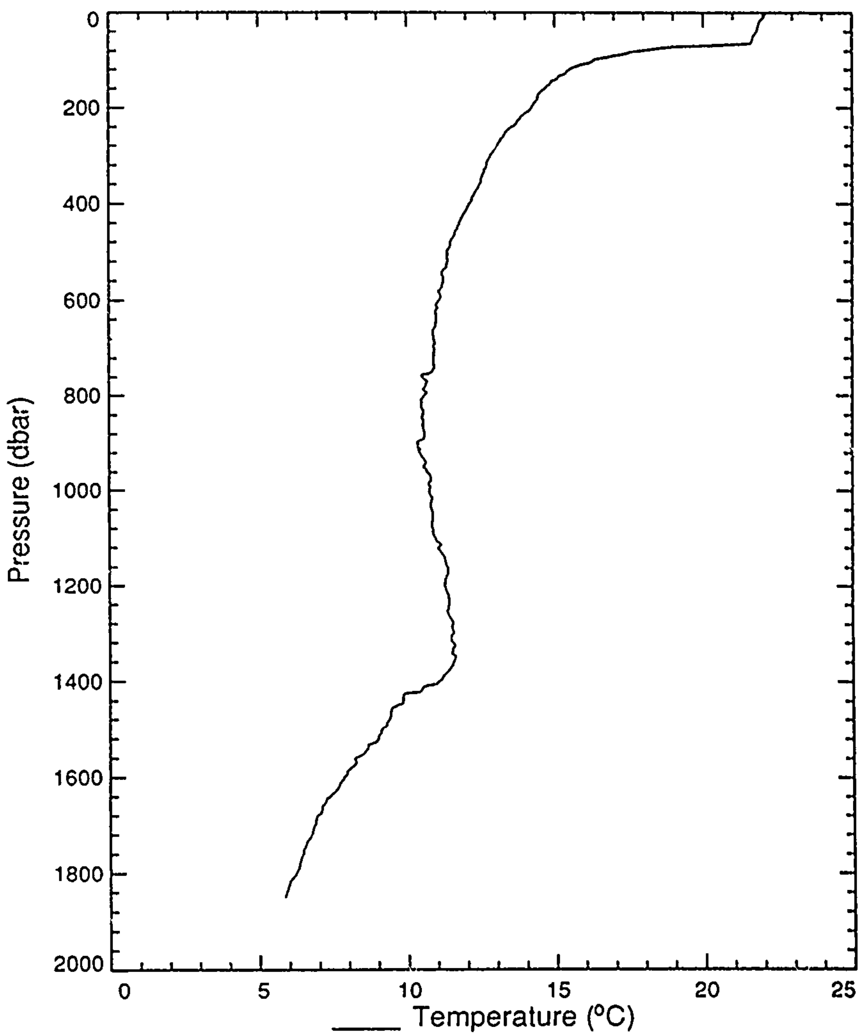

XBT 094
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25


XBT 093
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

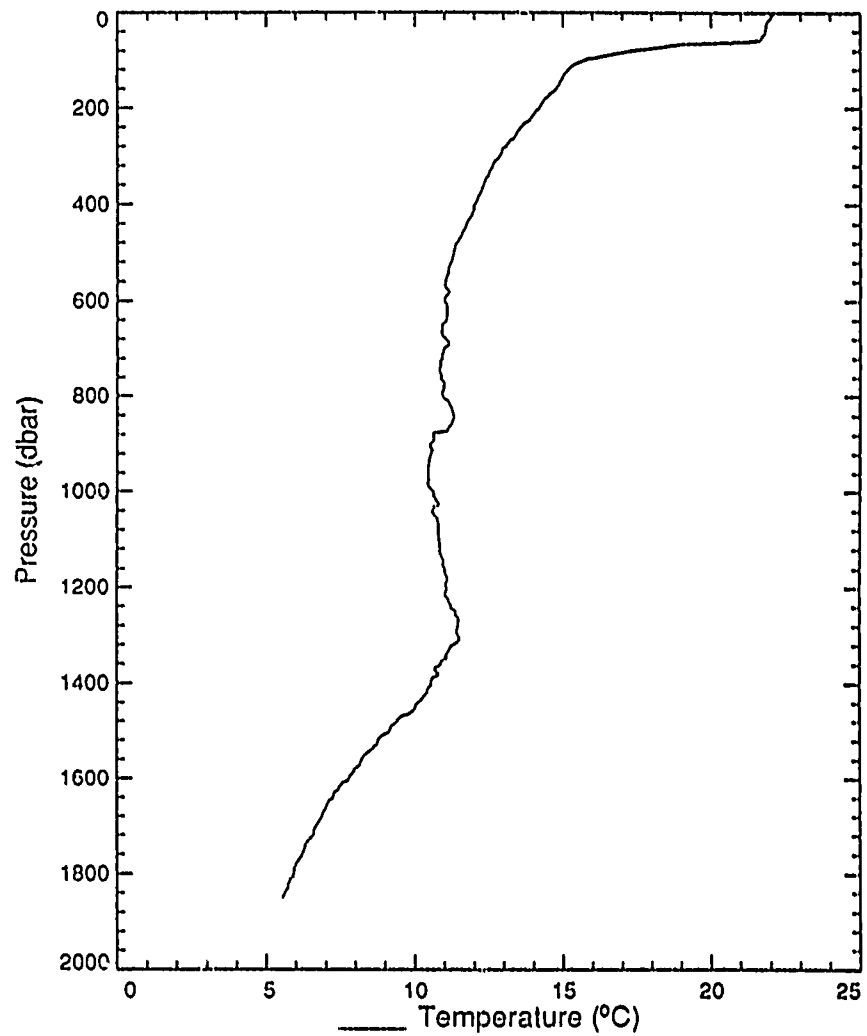

XBT 096
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

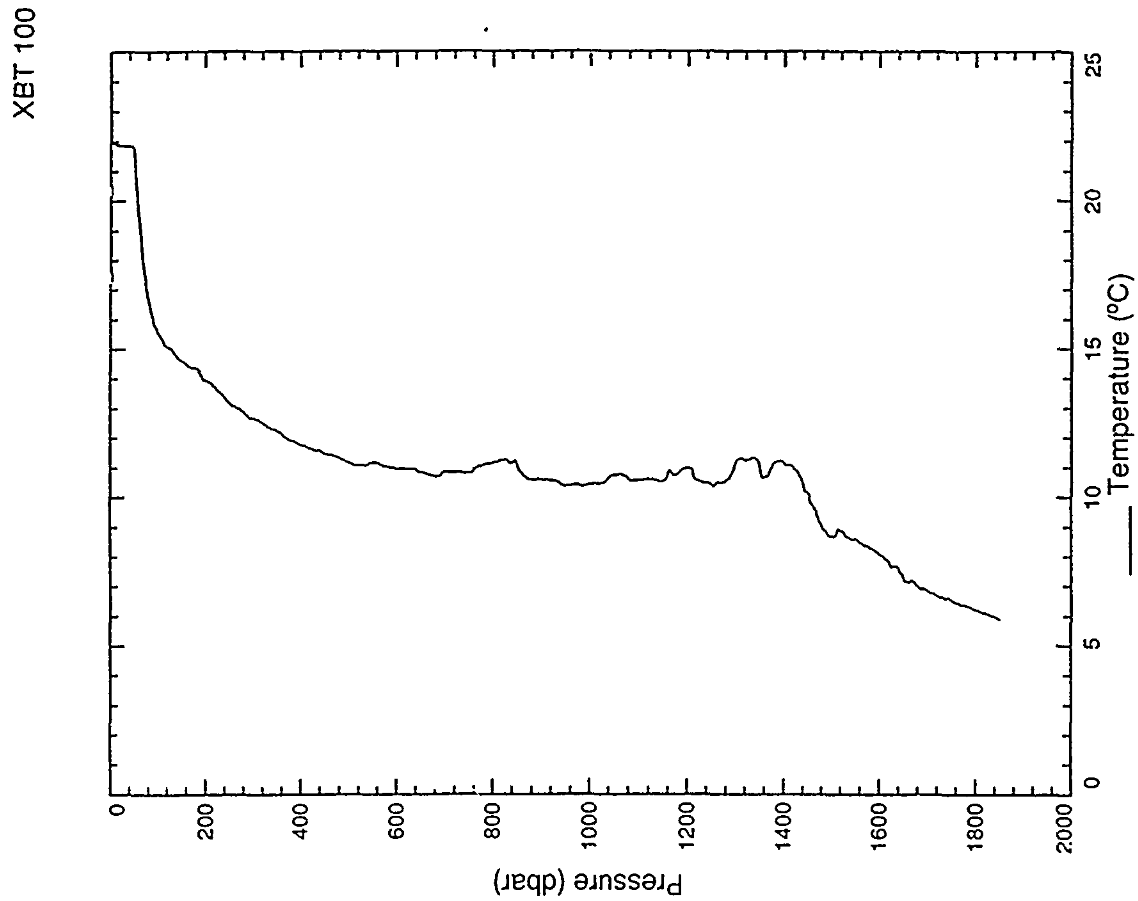

XBT 095
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

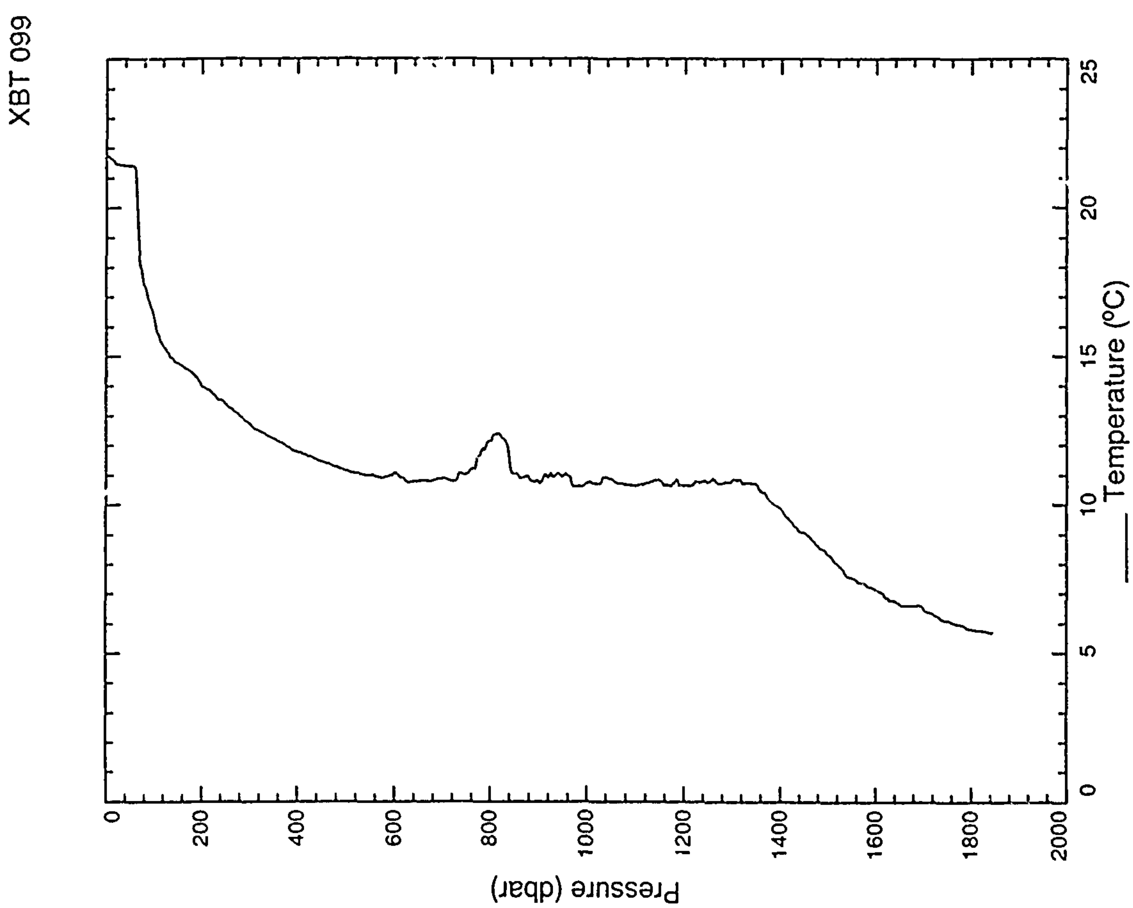
XBT 097



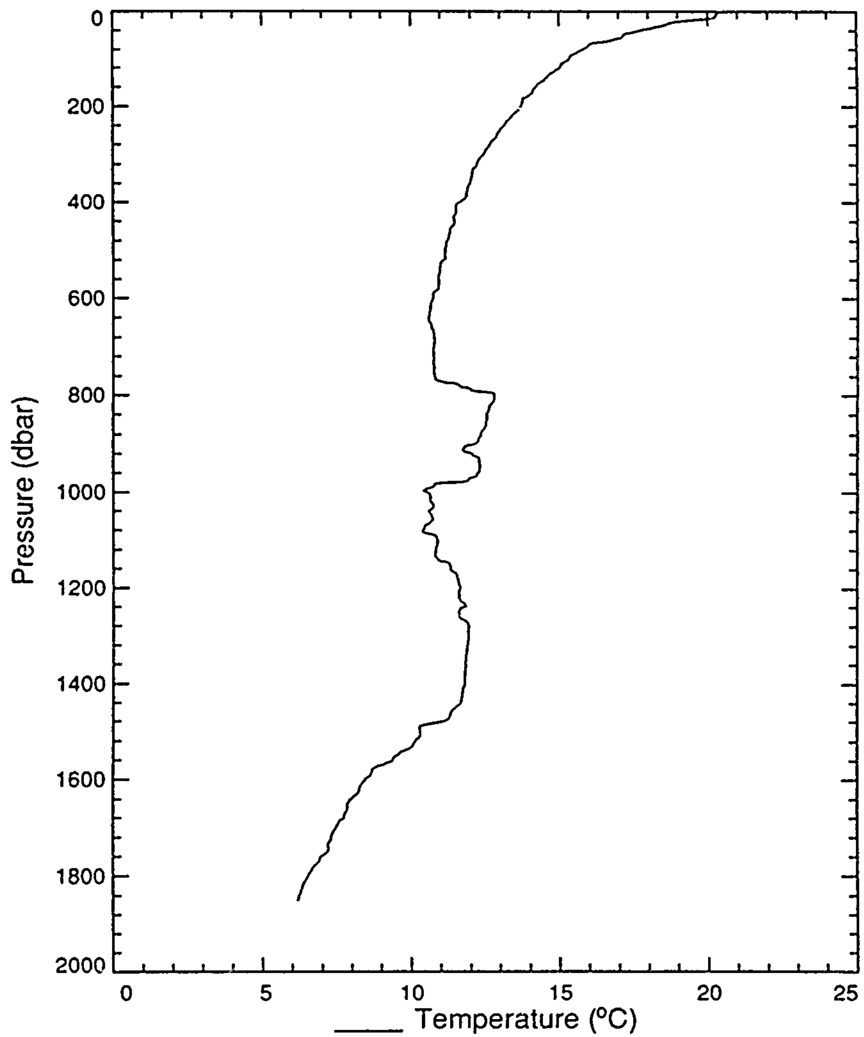
XBT 098




XBT 100
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 099
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

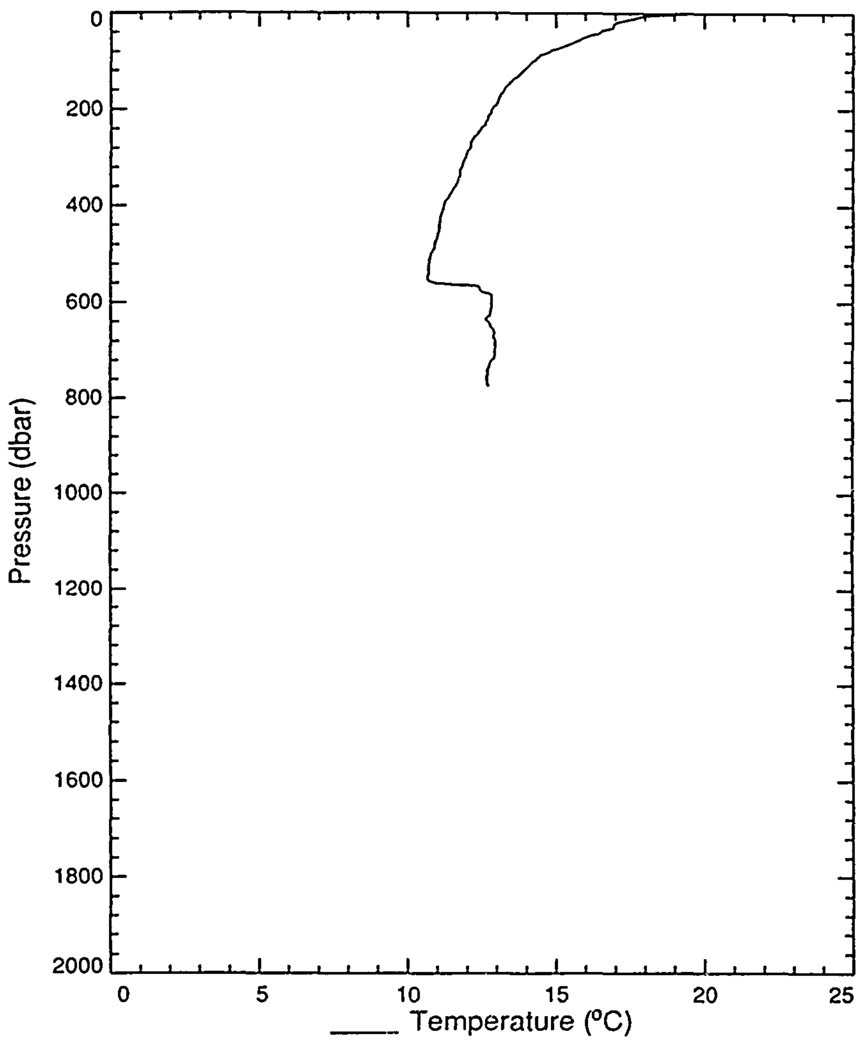
XBT 101



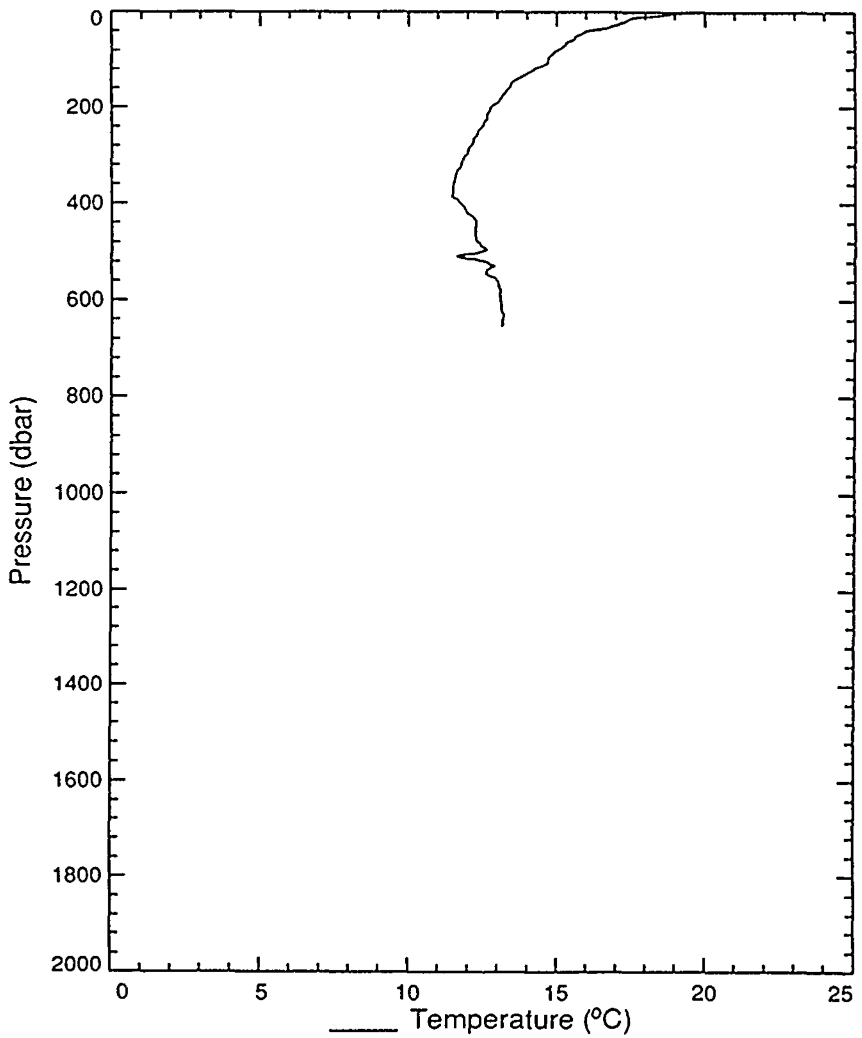
XBT 102

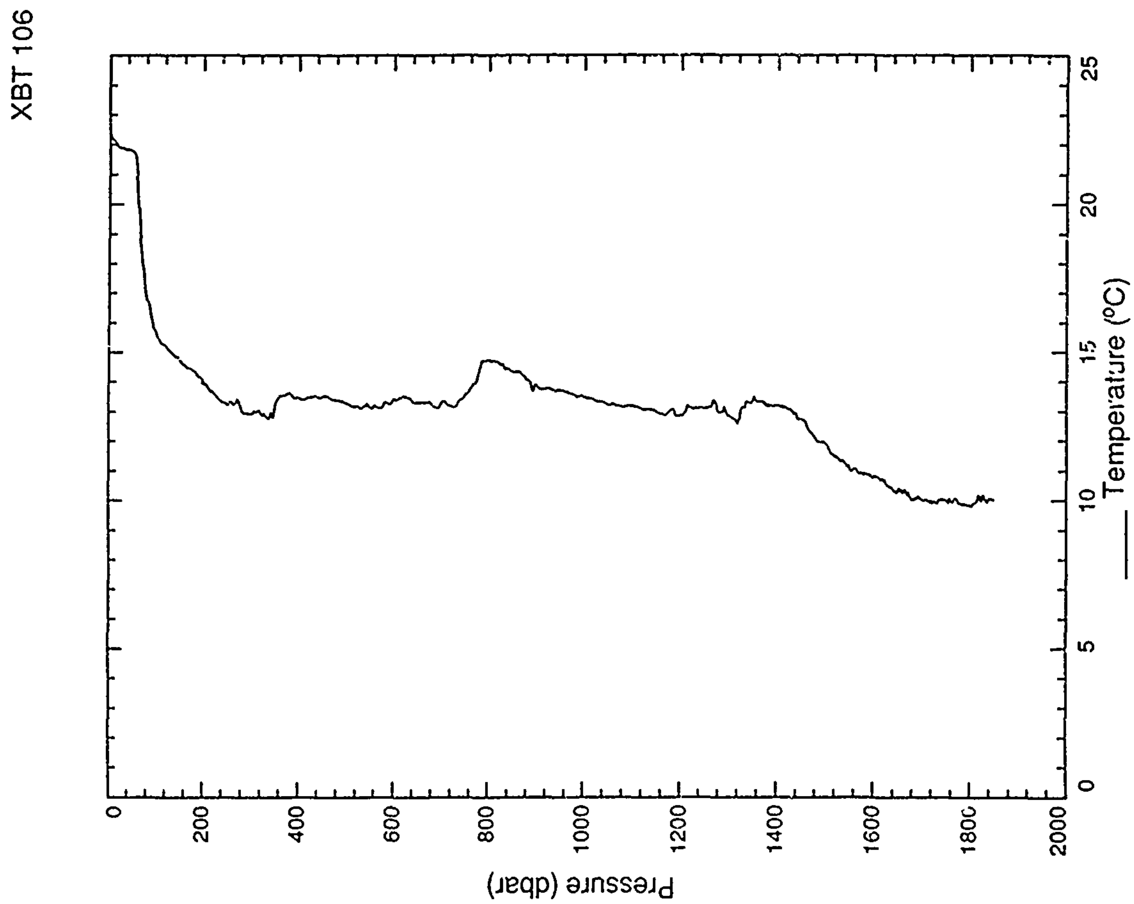
On Backup Tape Only

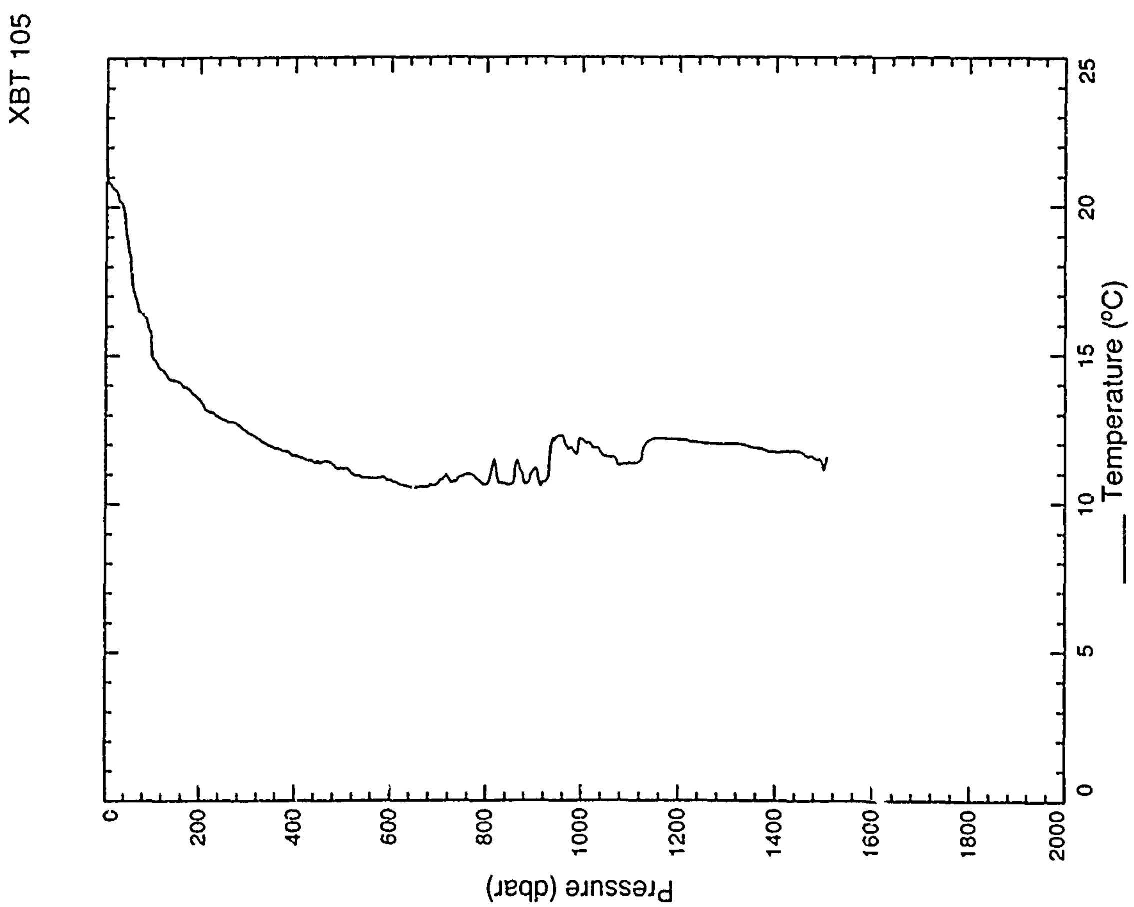
XBT 103



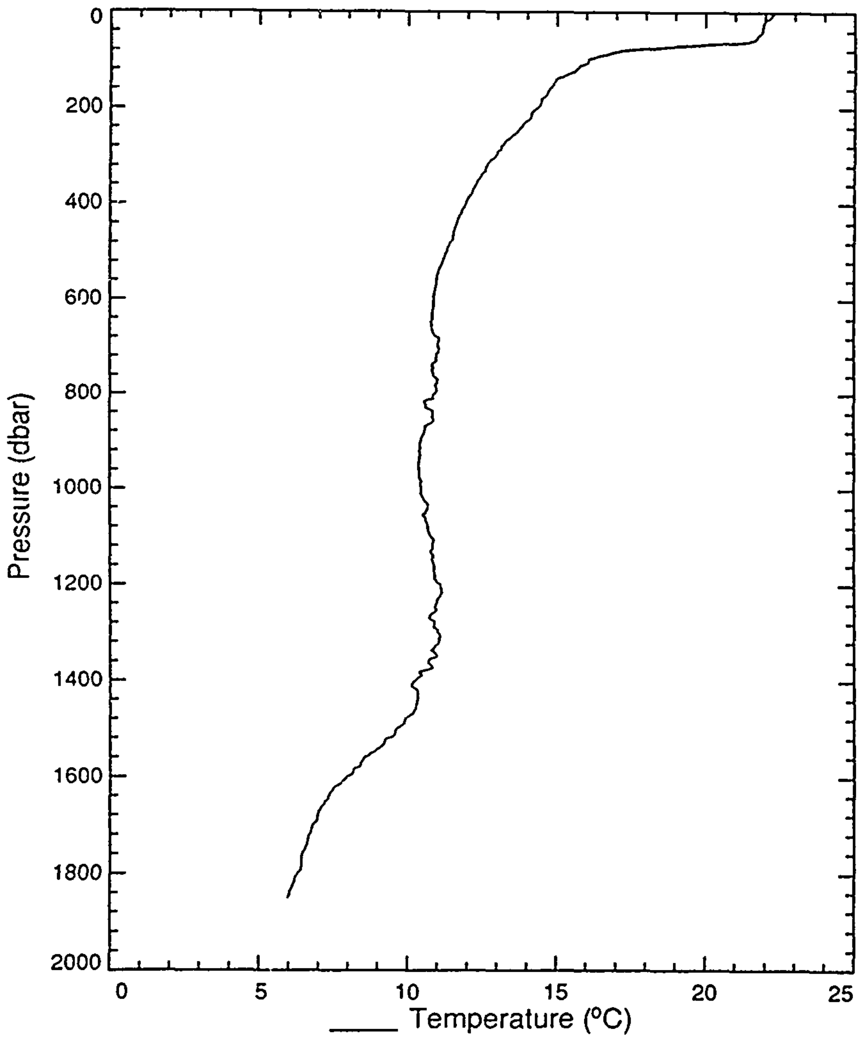
XBT 104



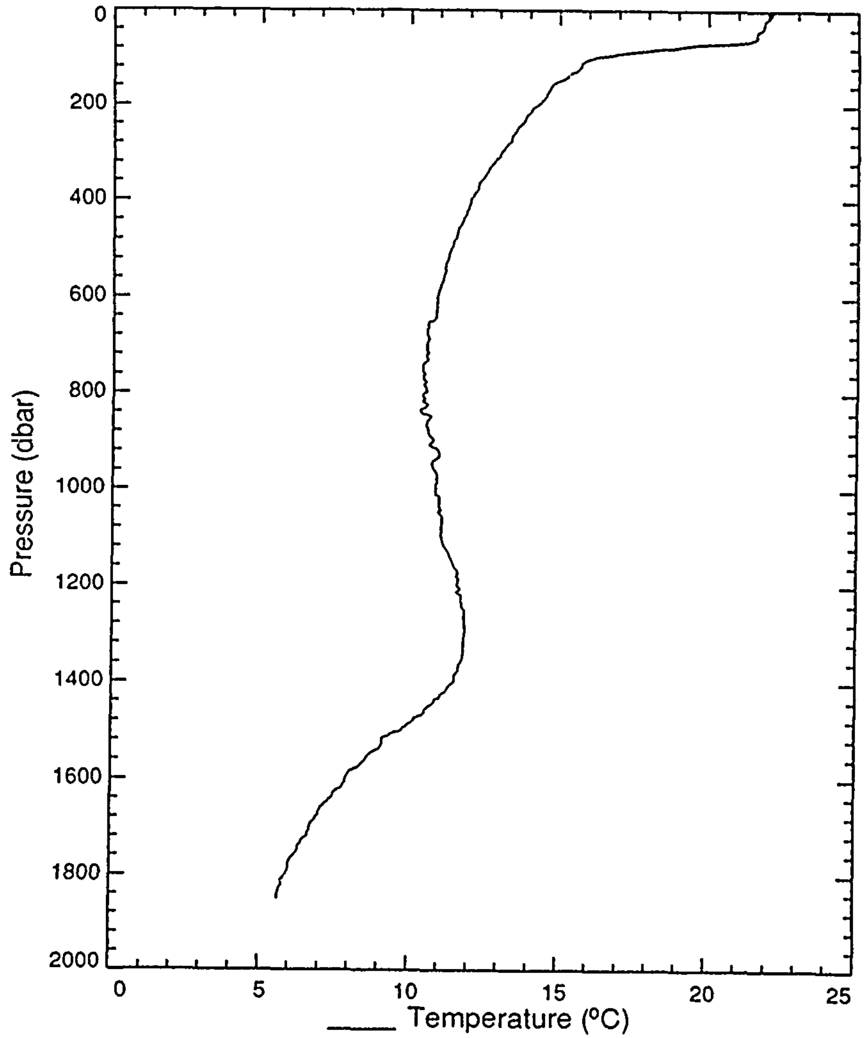

XBT 106
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

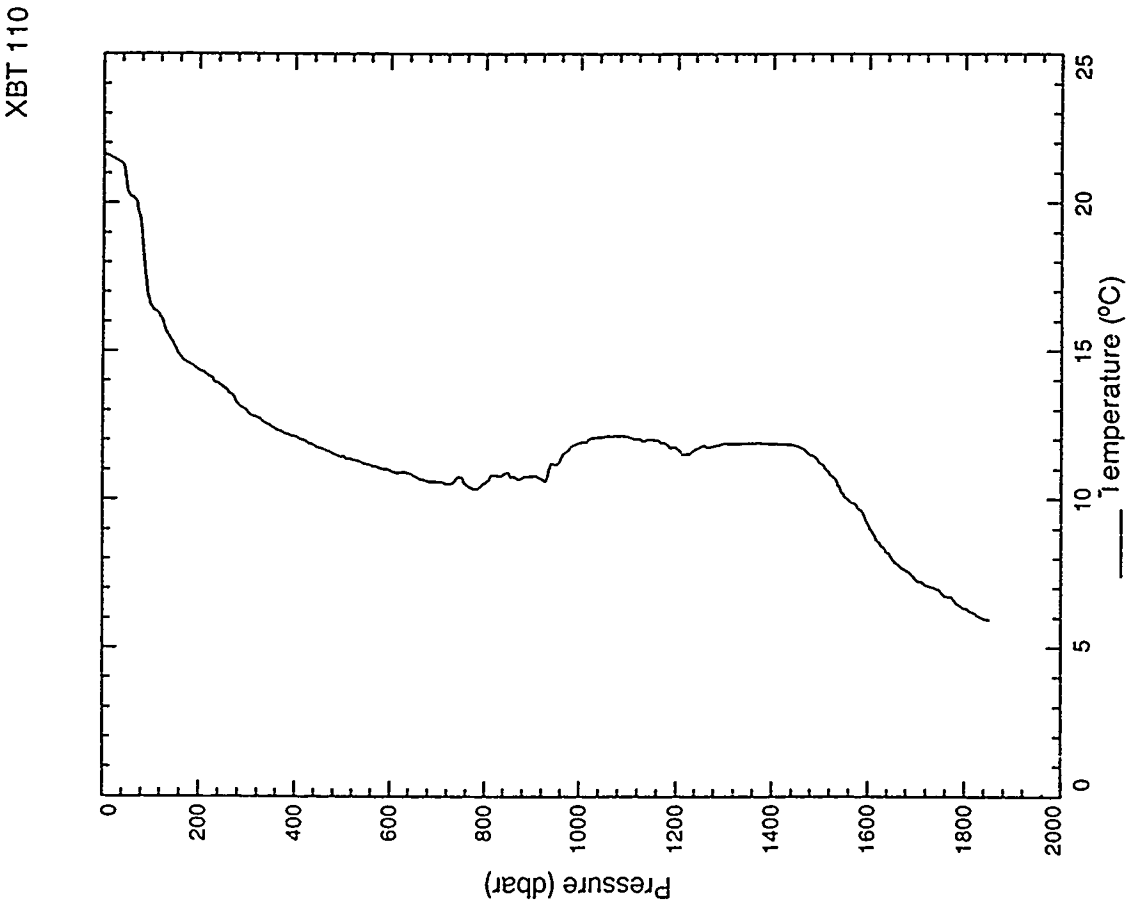

XBT 105
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

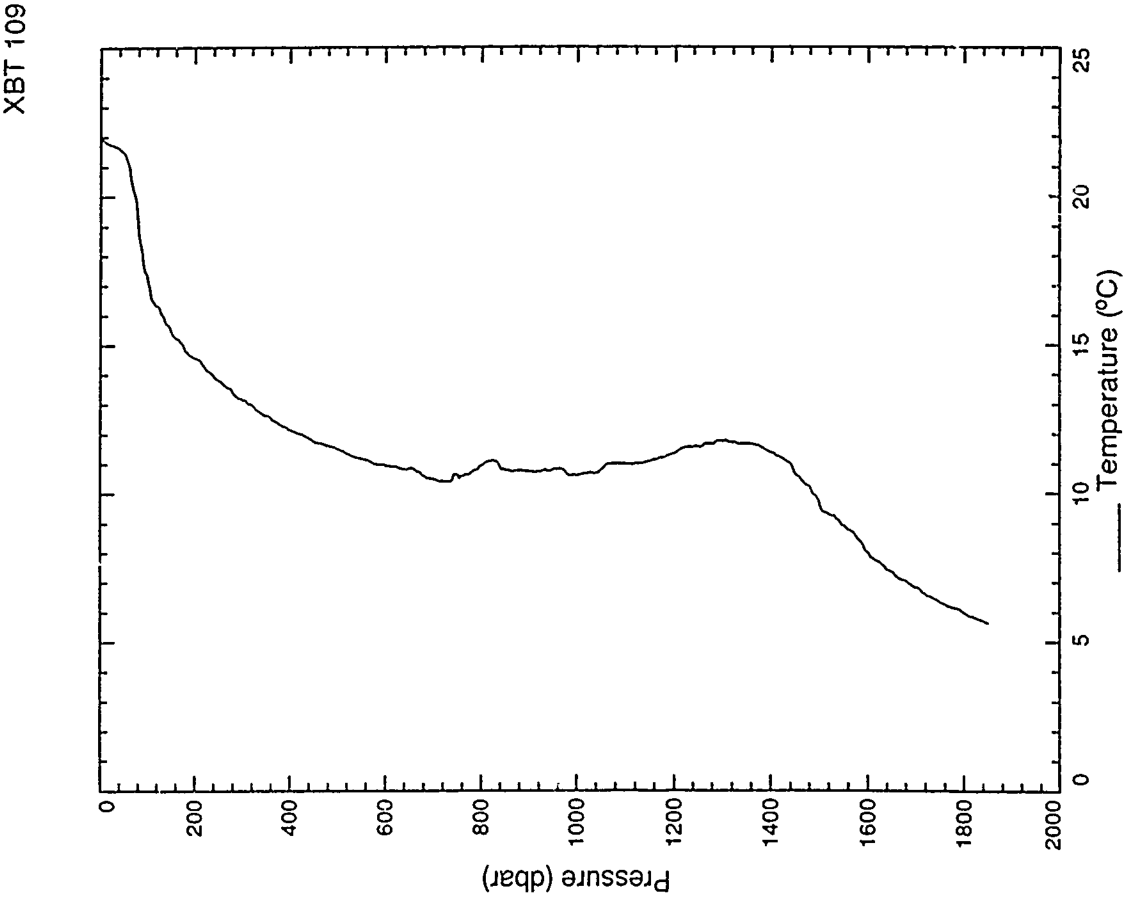
XBT 107



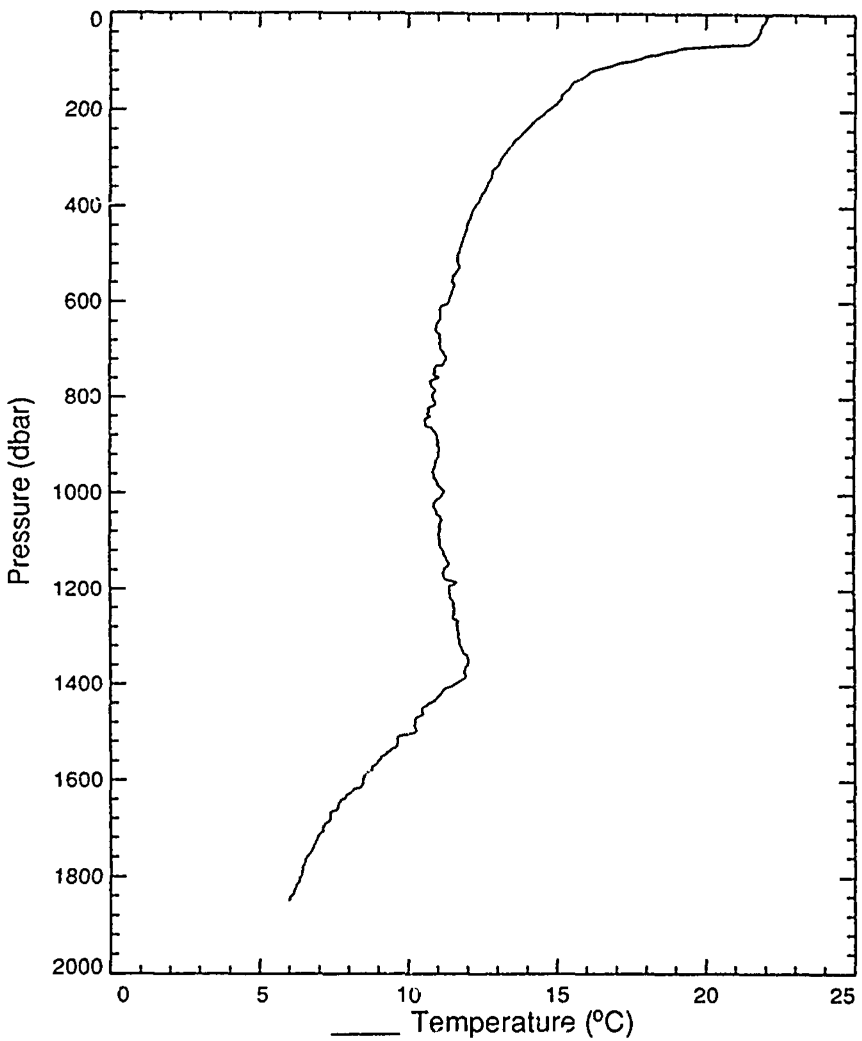
XBT 108



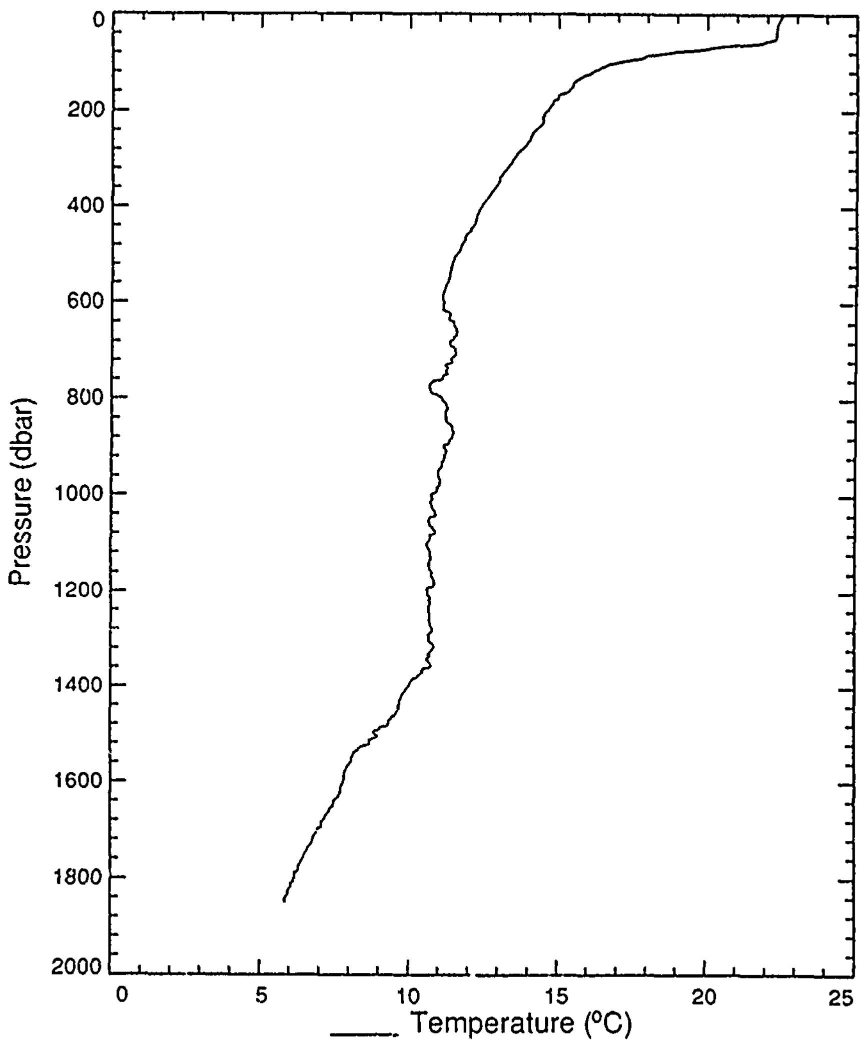

XBT 110
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (ºC)

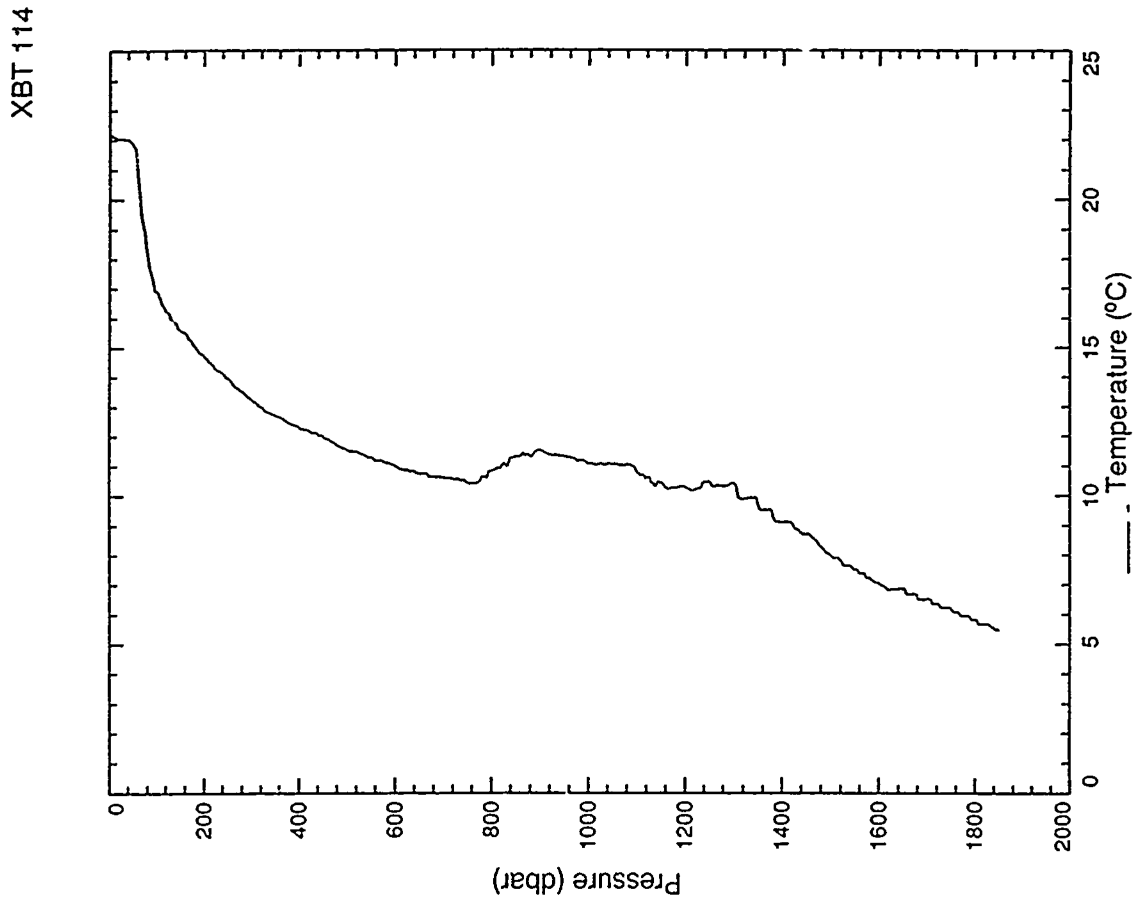

XBT 109
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (ºC)

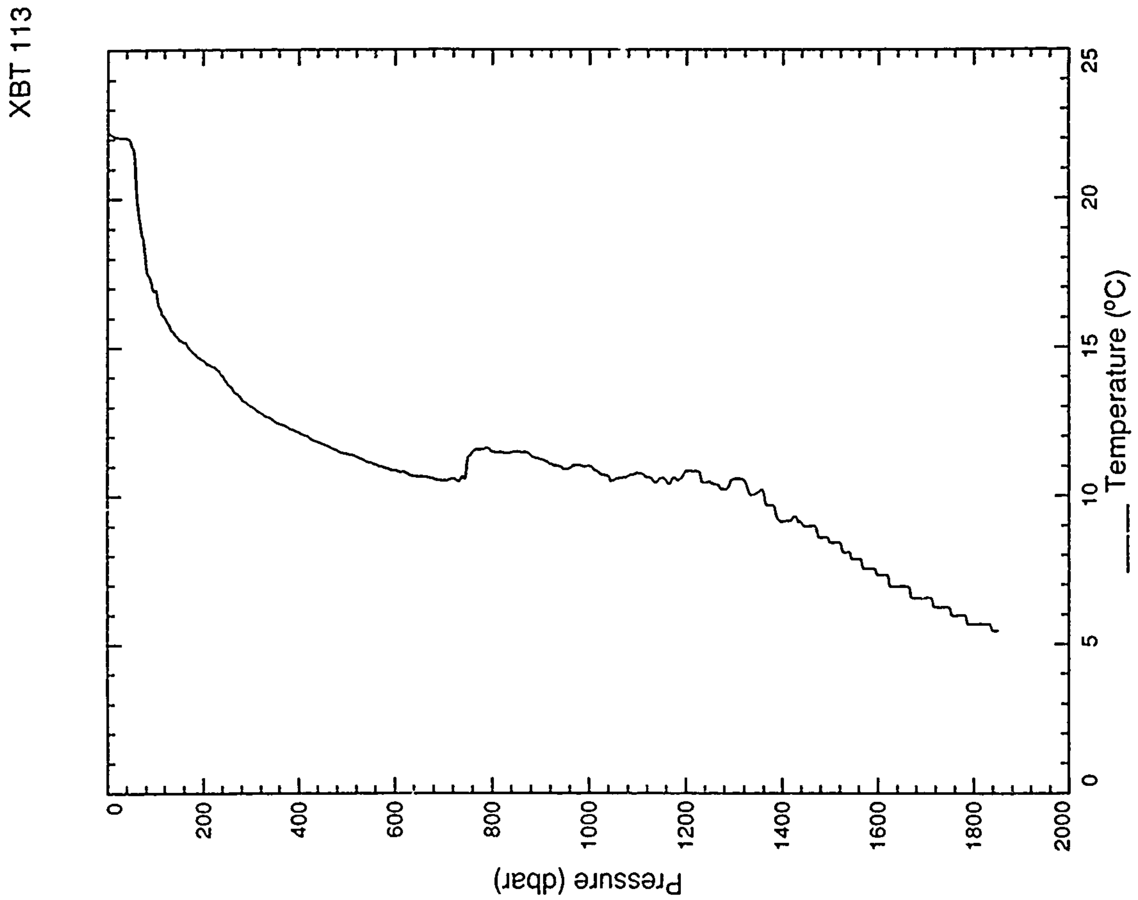
XBT 111



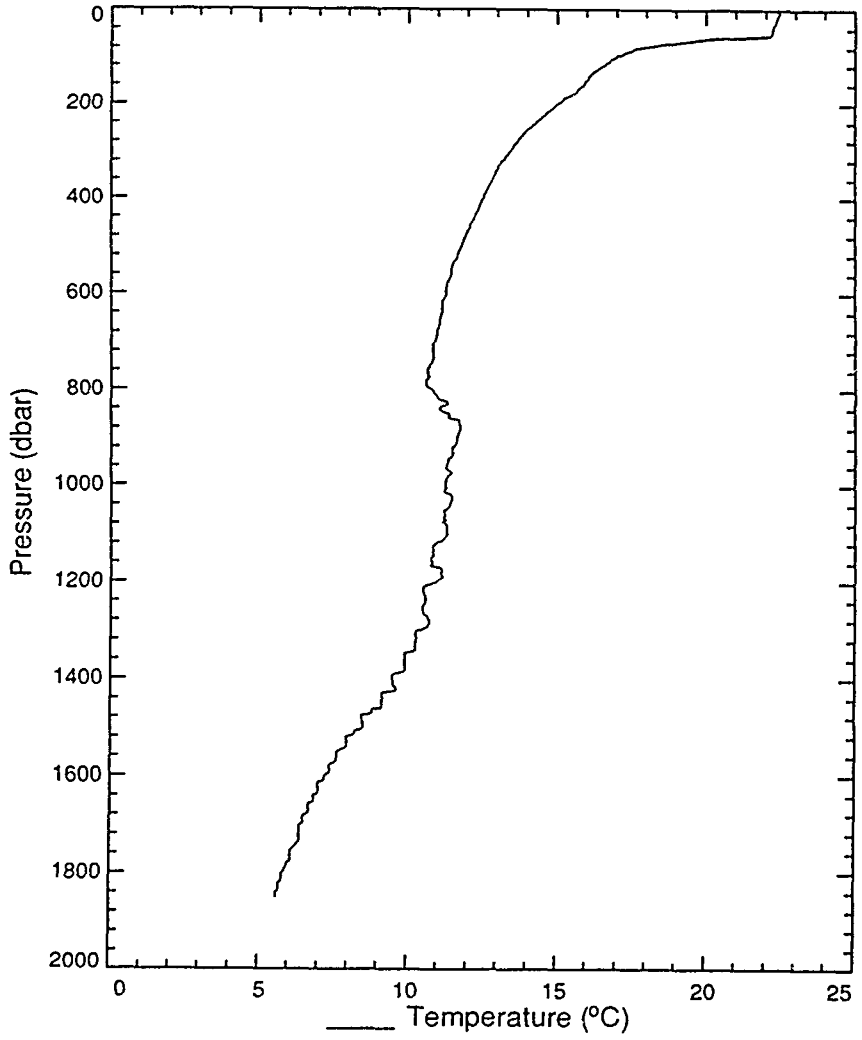
XBT 112



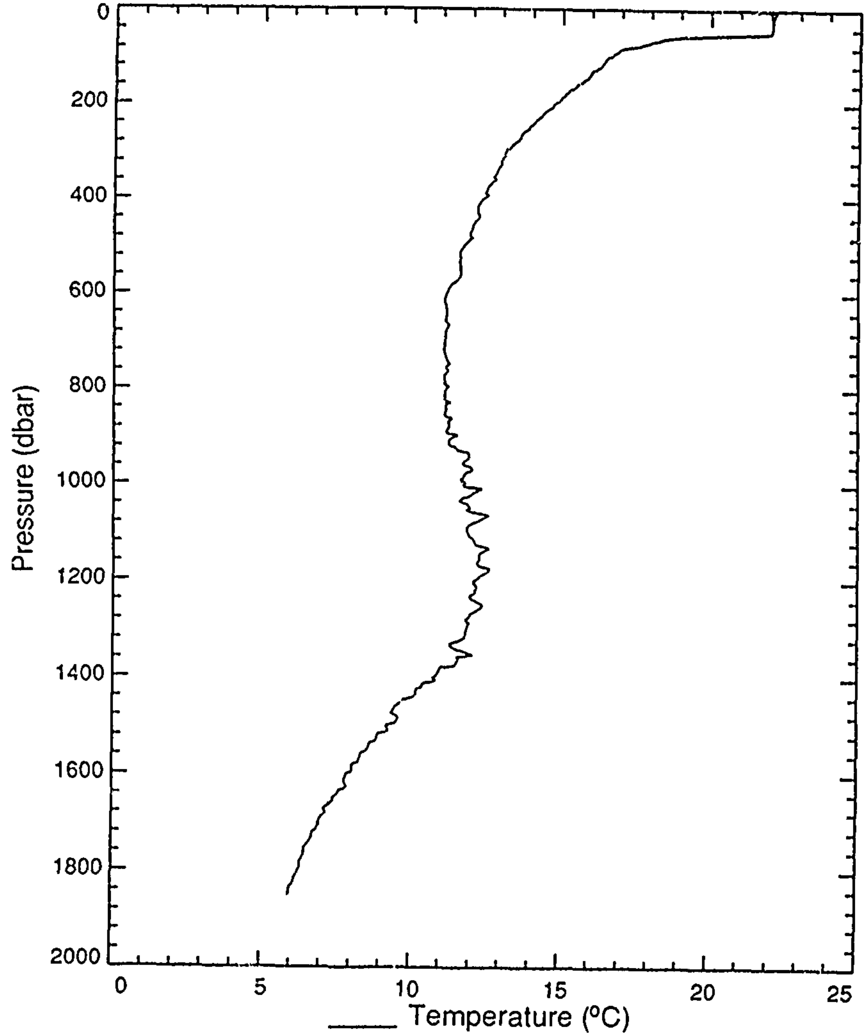

XBT 114
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

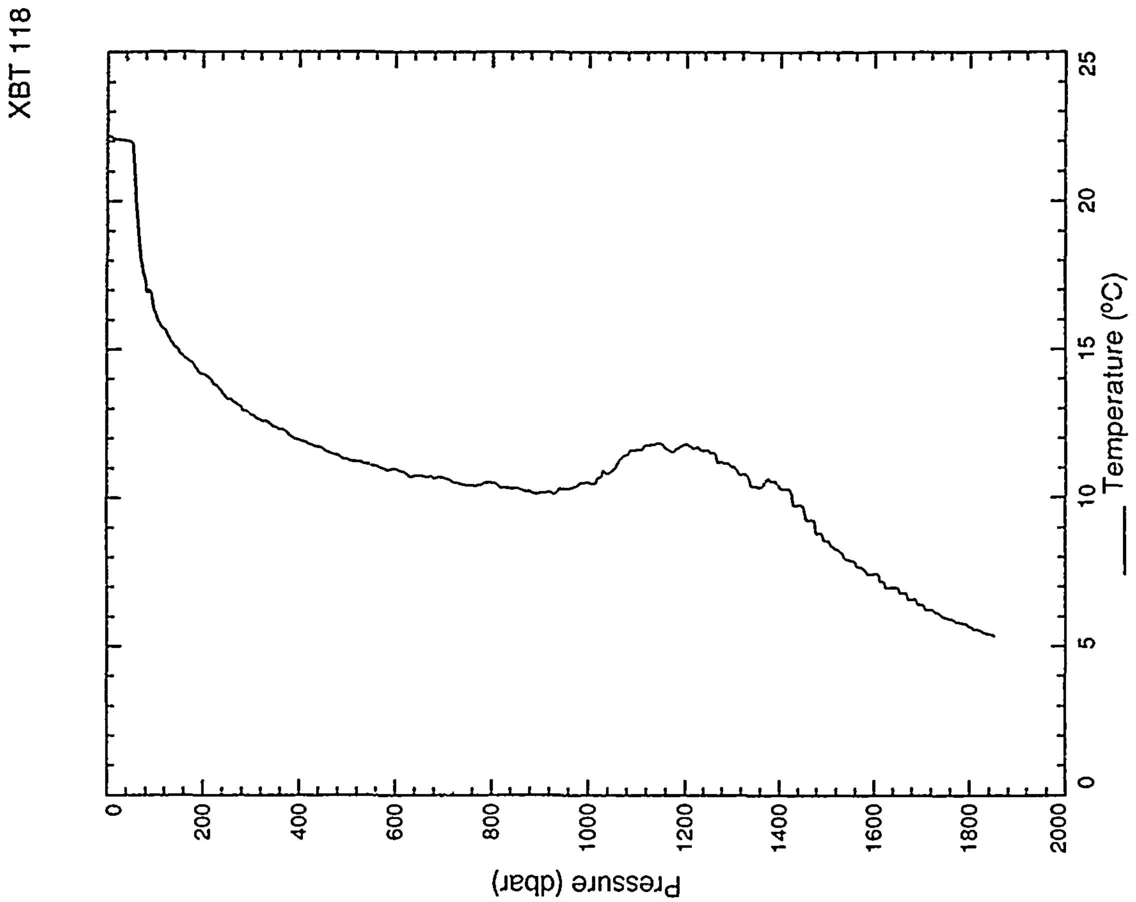

XBT 113
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

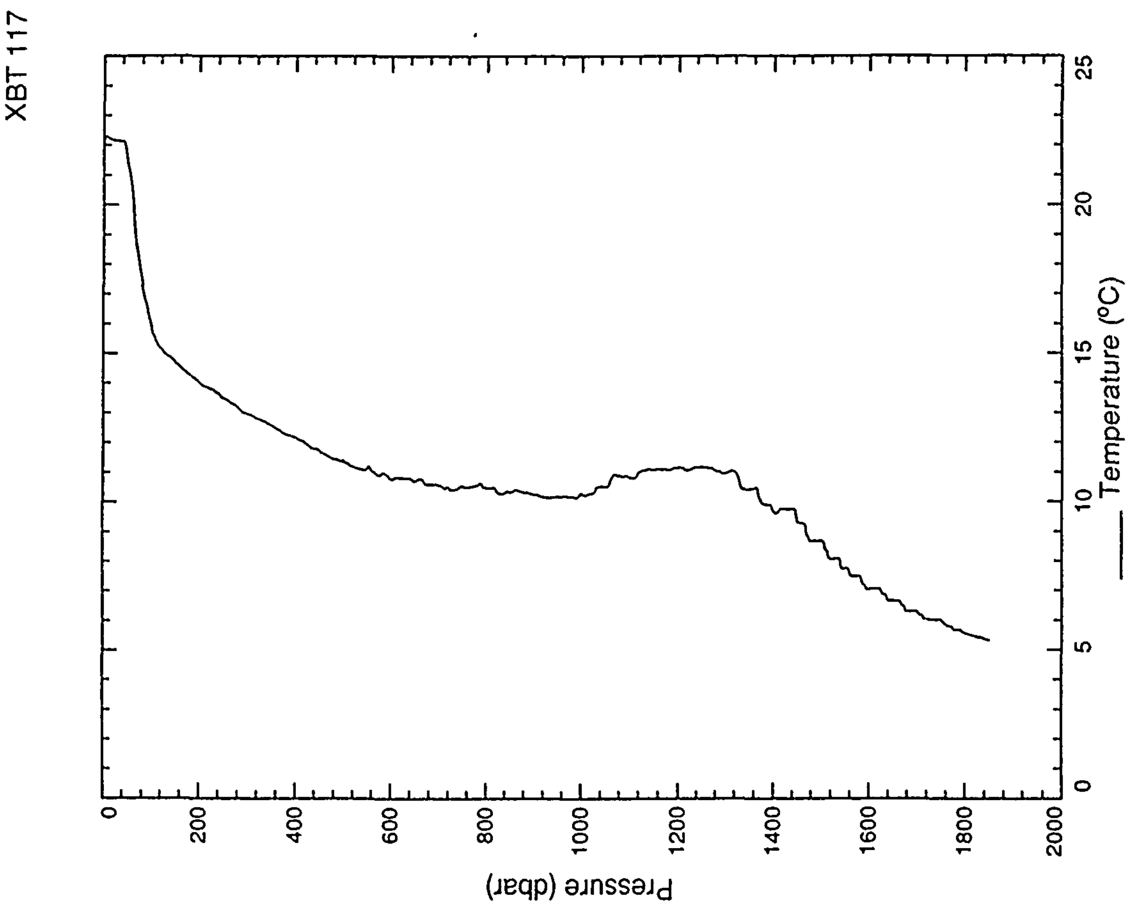
XBT 115

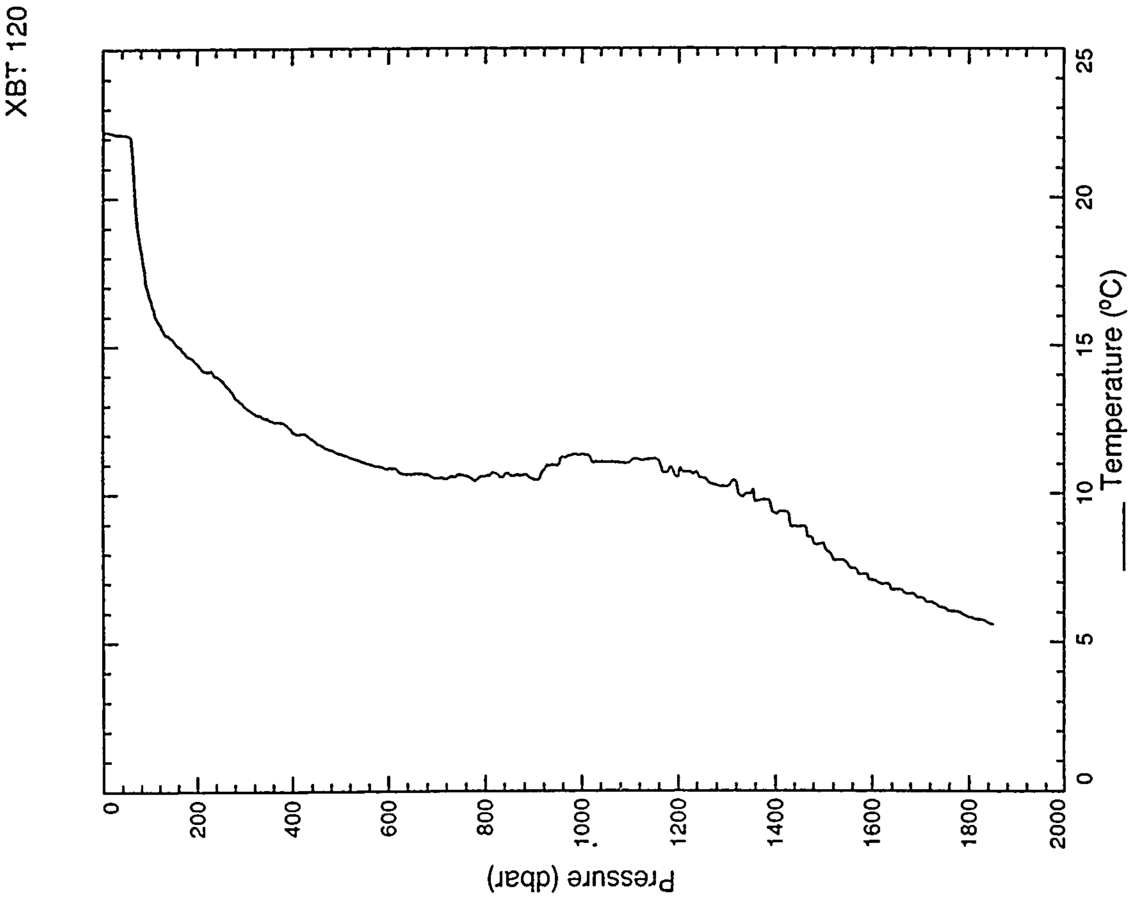


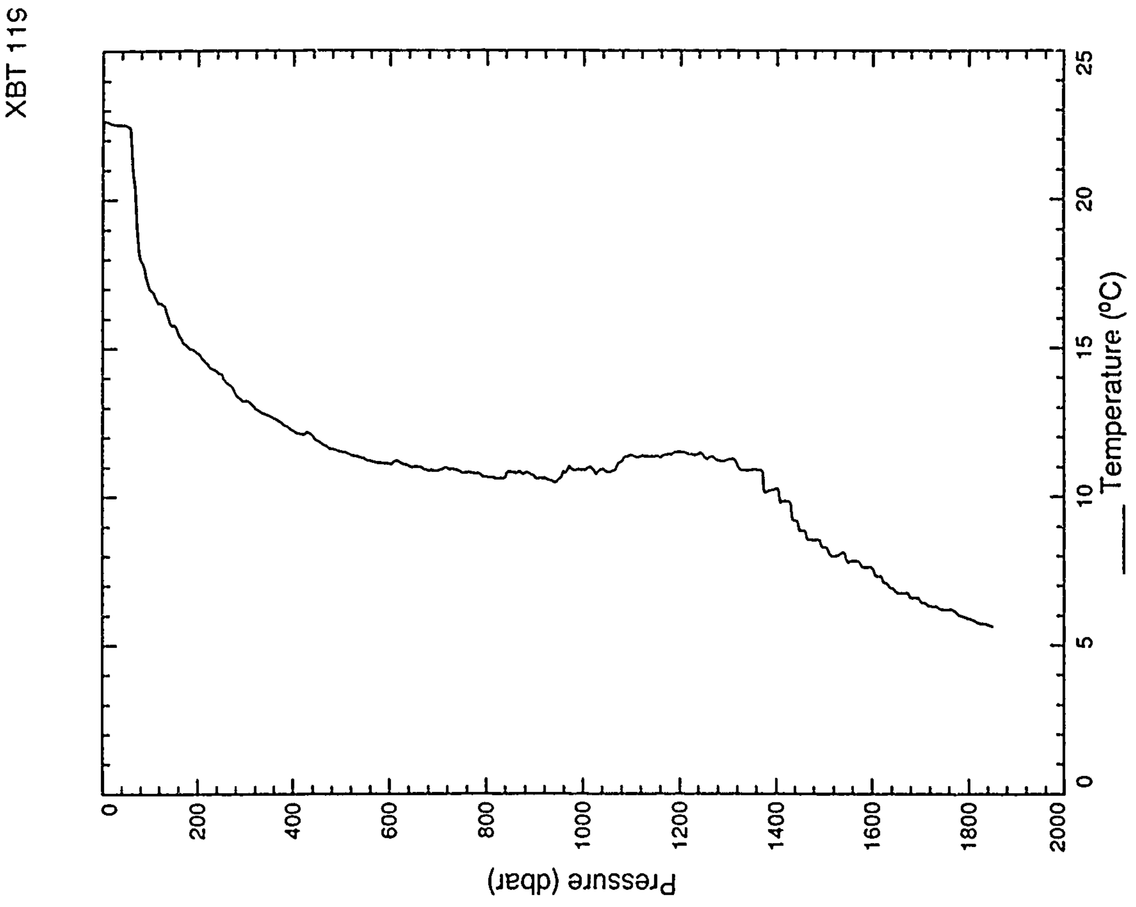
XBT 116

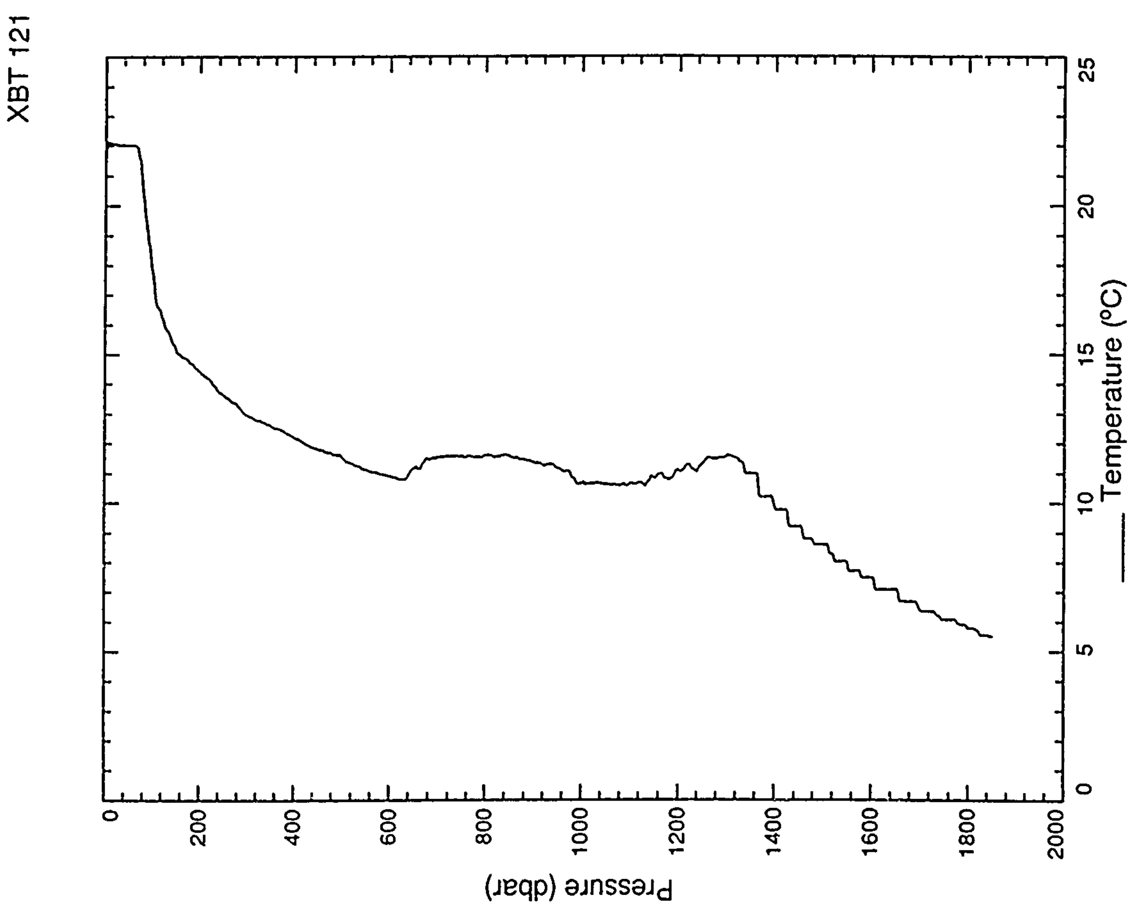


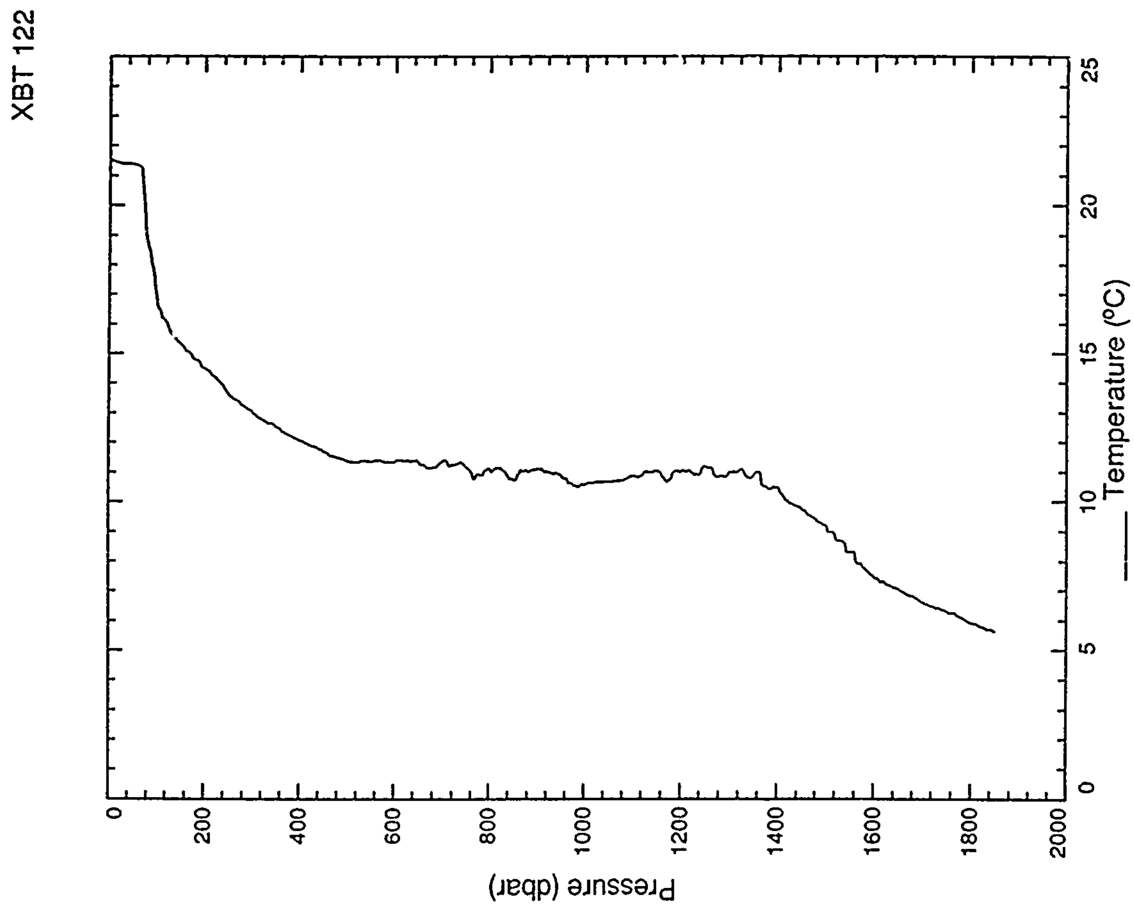

XBT 118
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 117
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

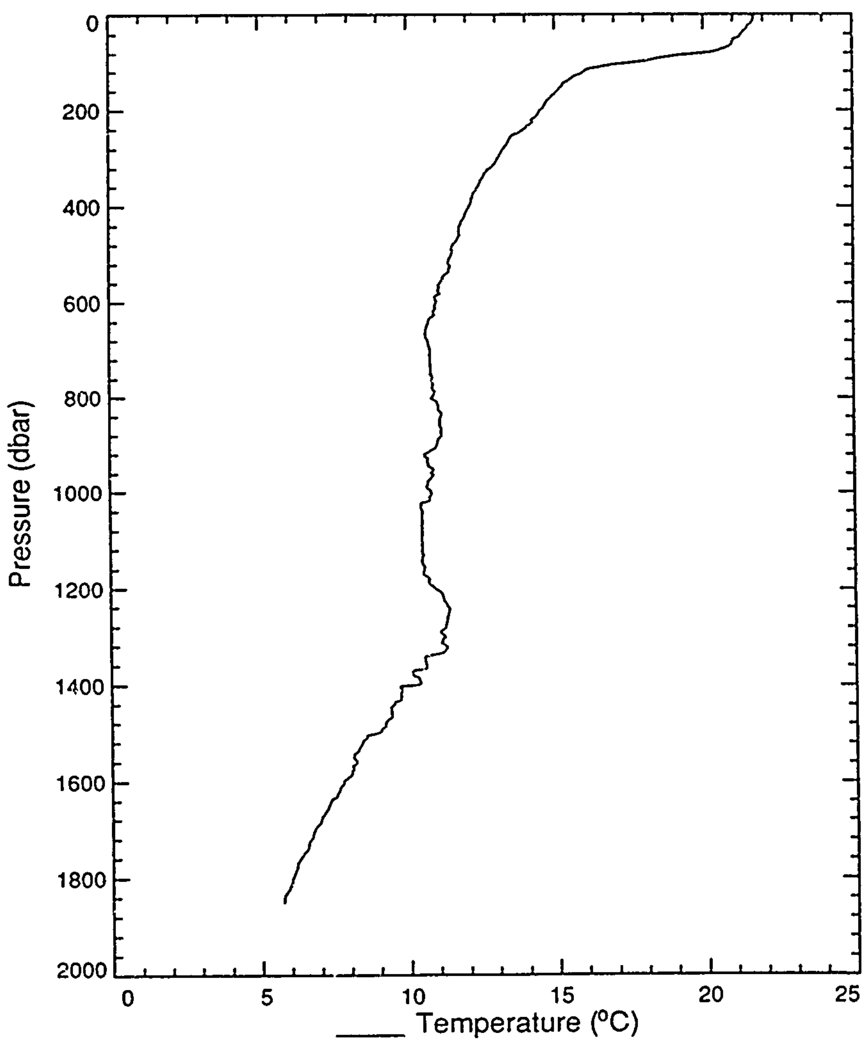

XBT 120
Pressure (dbar)
Temperature (°C)


XBT 119
Pressure (dbar)
Temperature (°C)

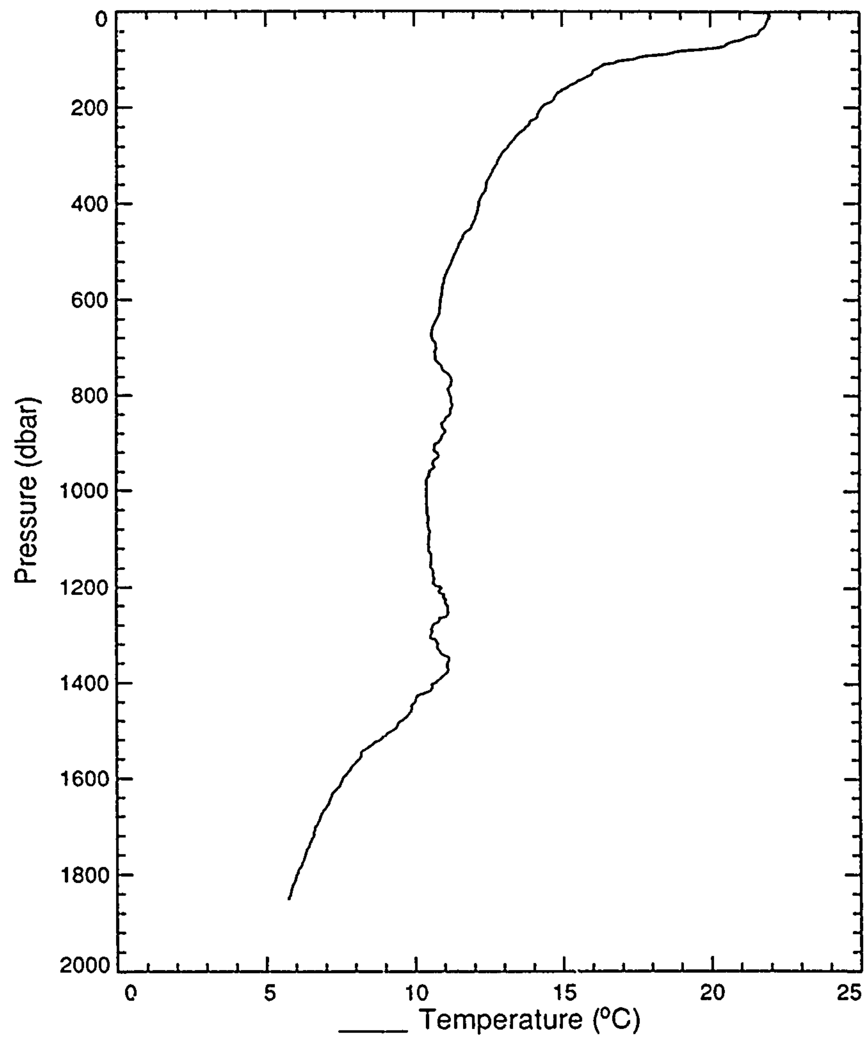

XBT 121
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 122
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

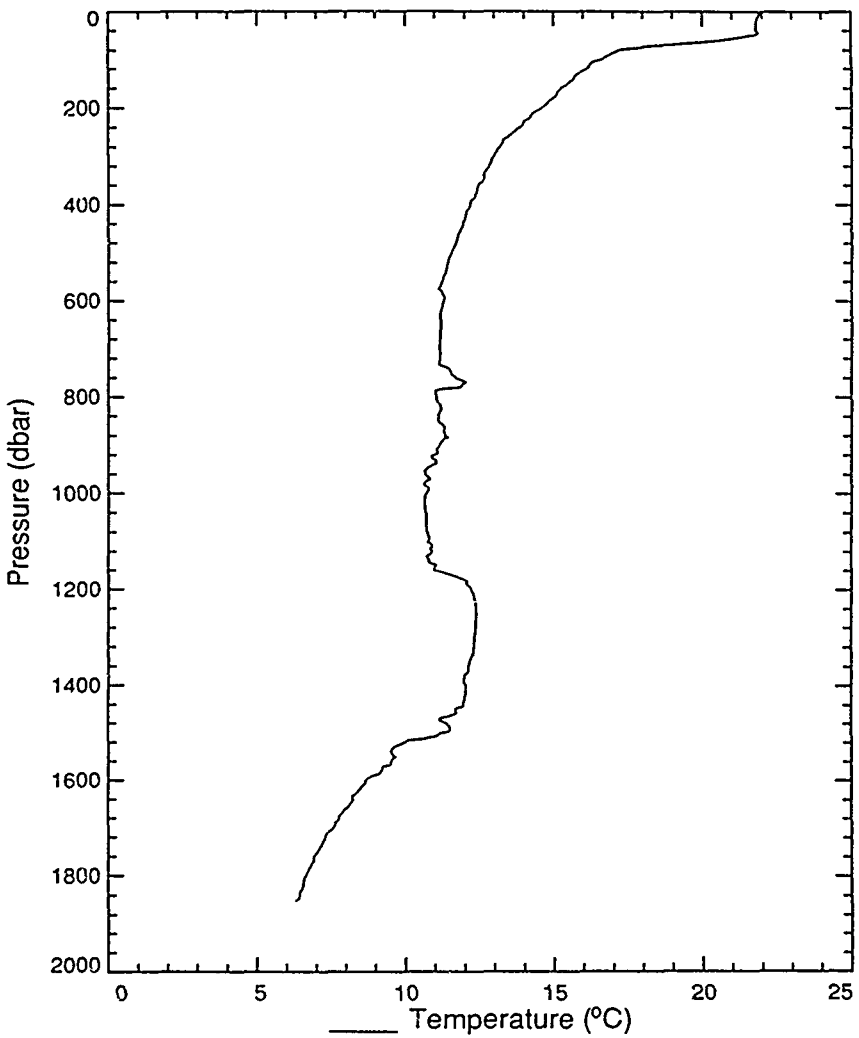
XBT 123



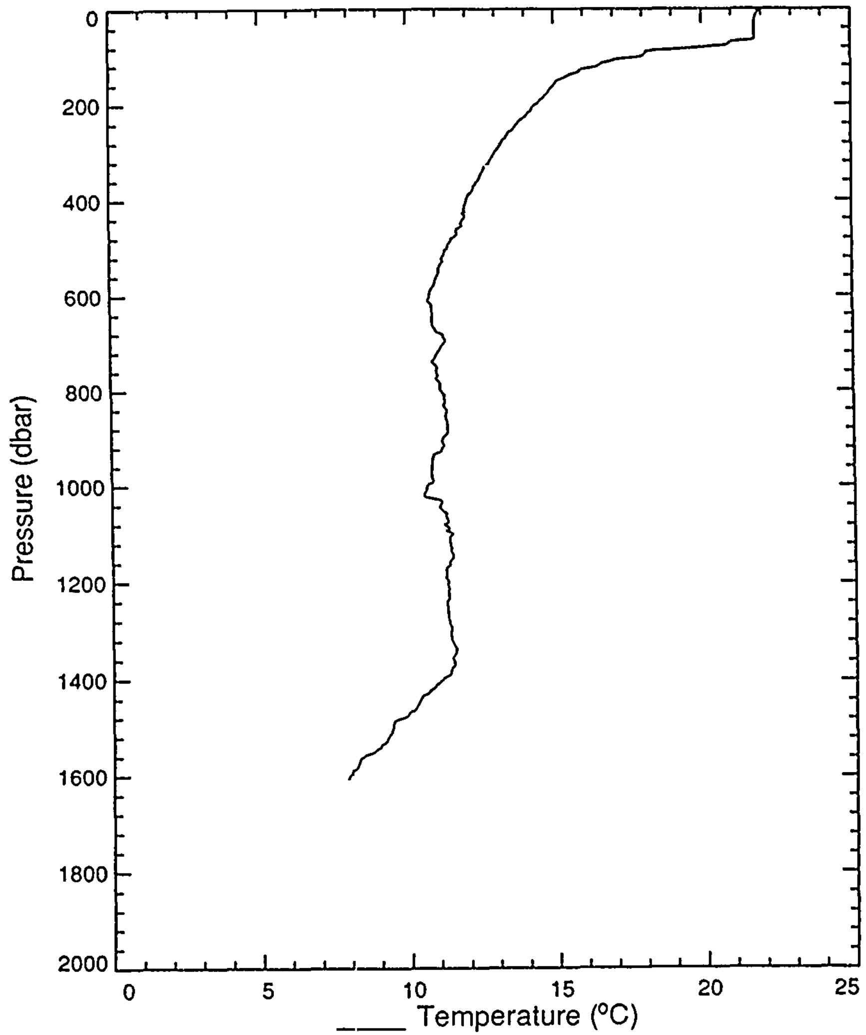
XBT 124



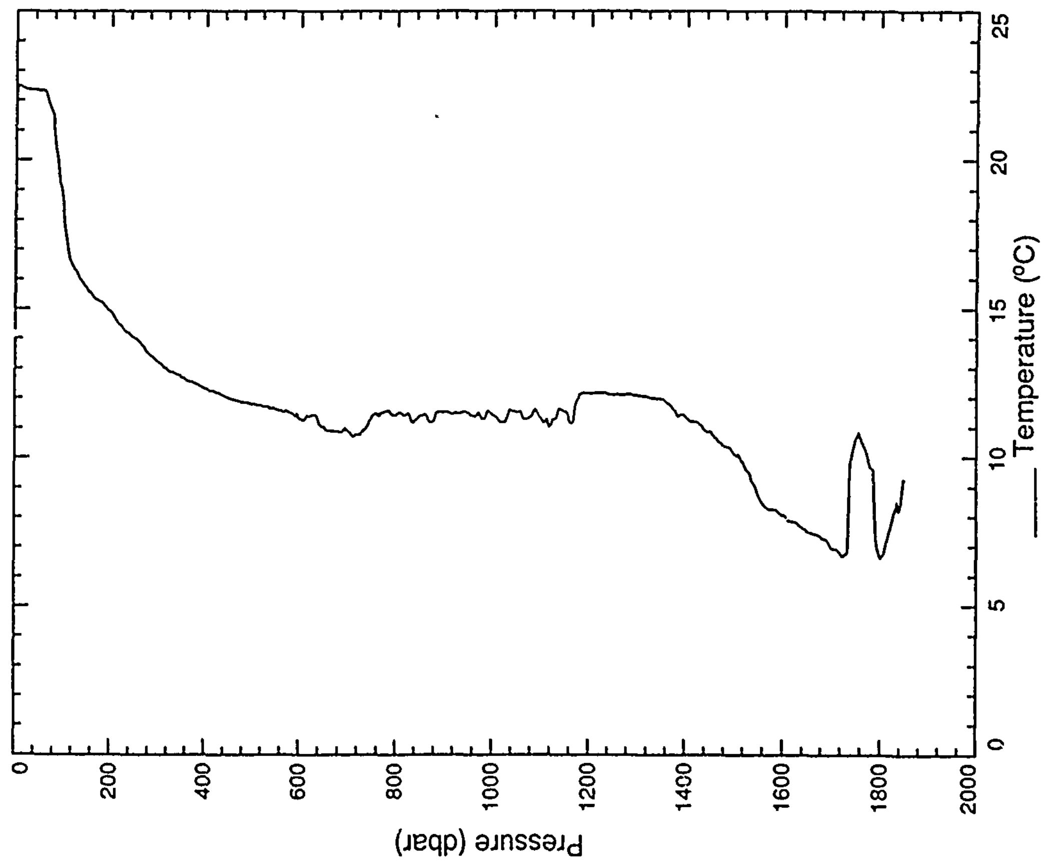
XBT 125



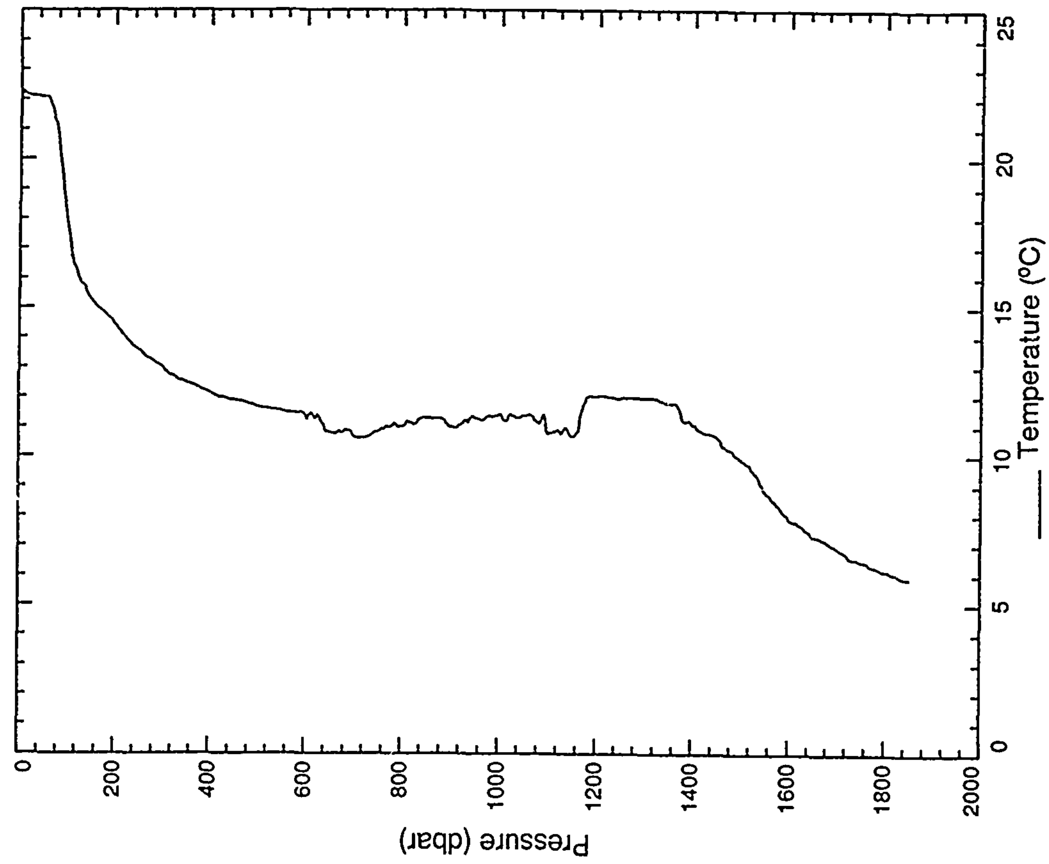
XBT 126



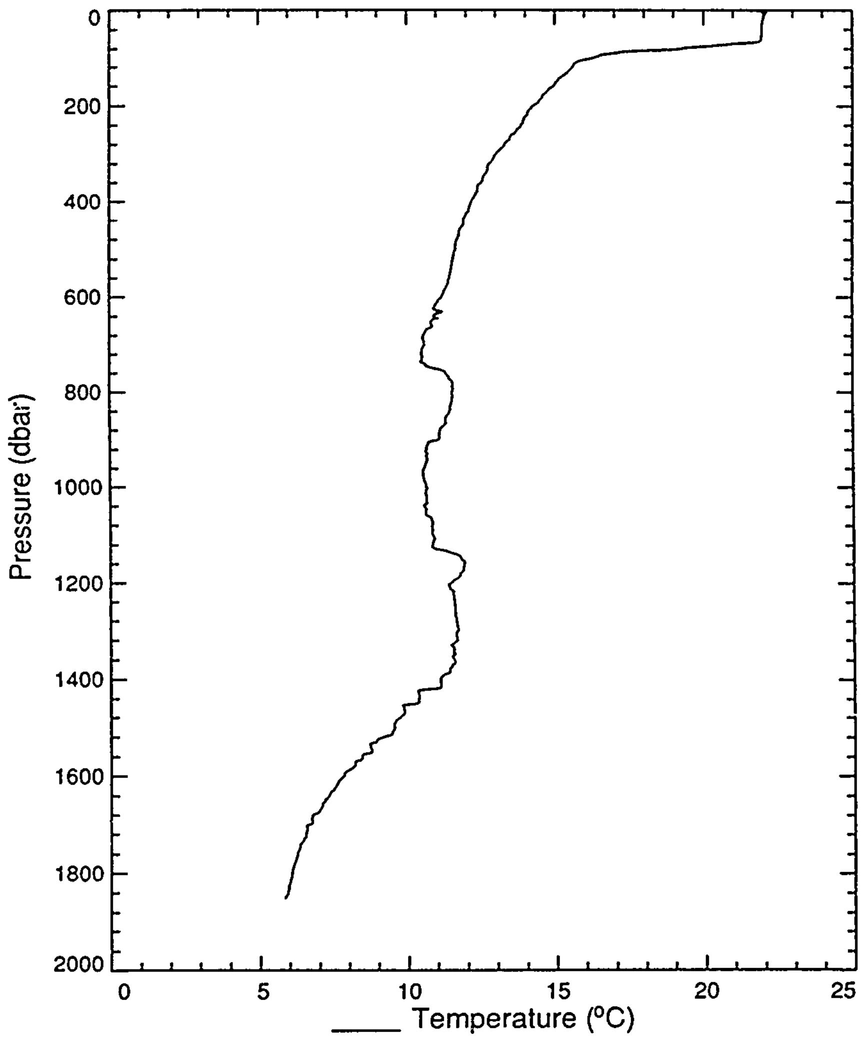
XBT 127



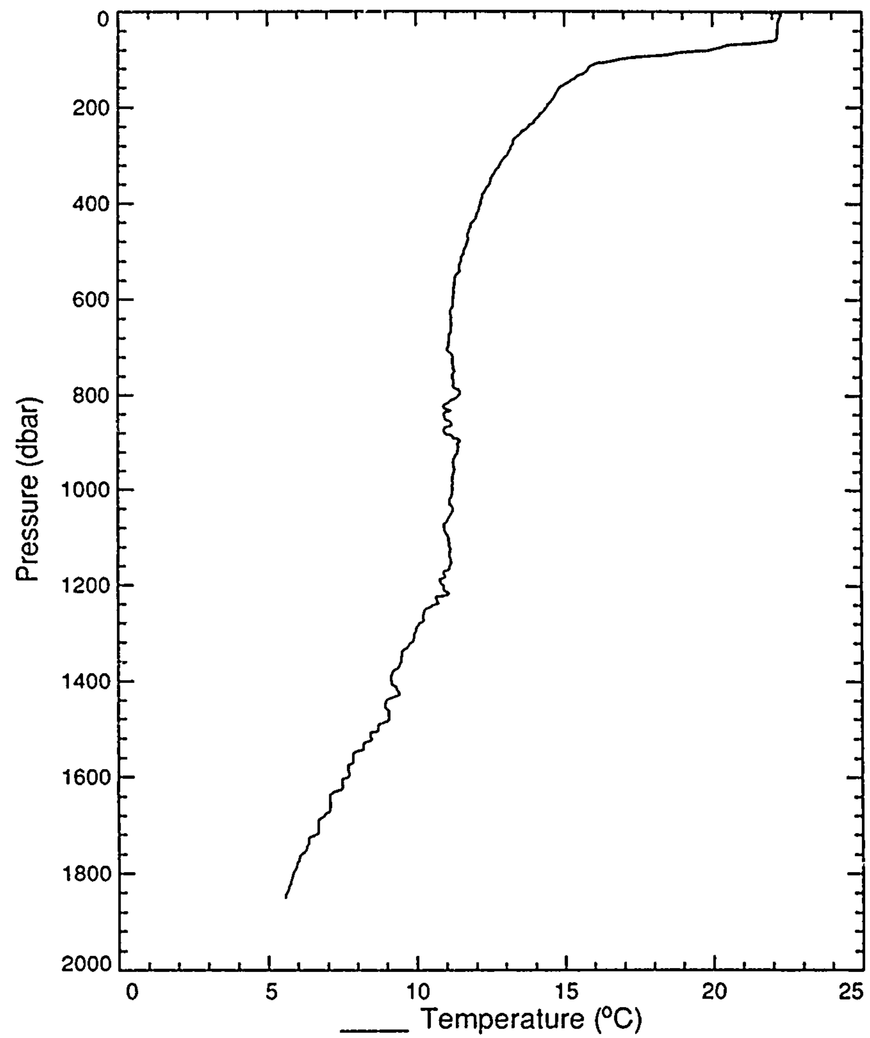
XBT 128



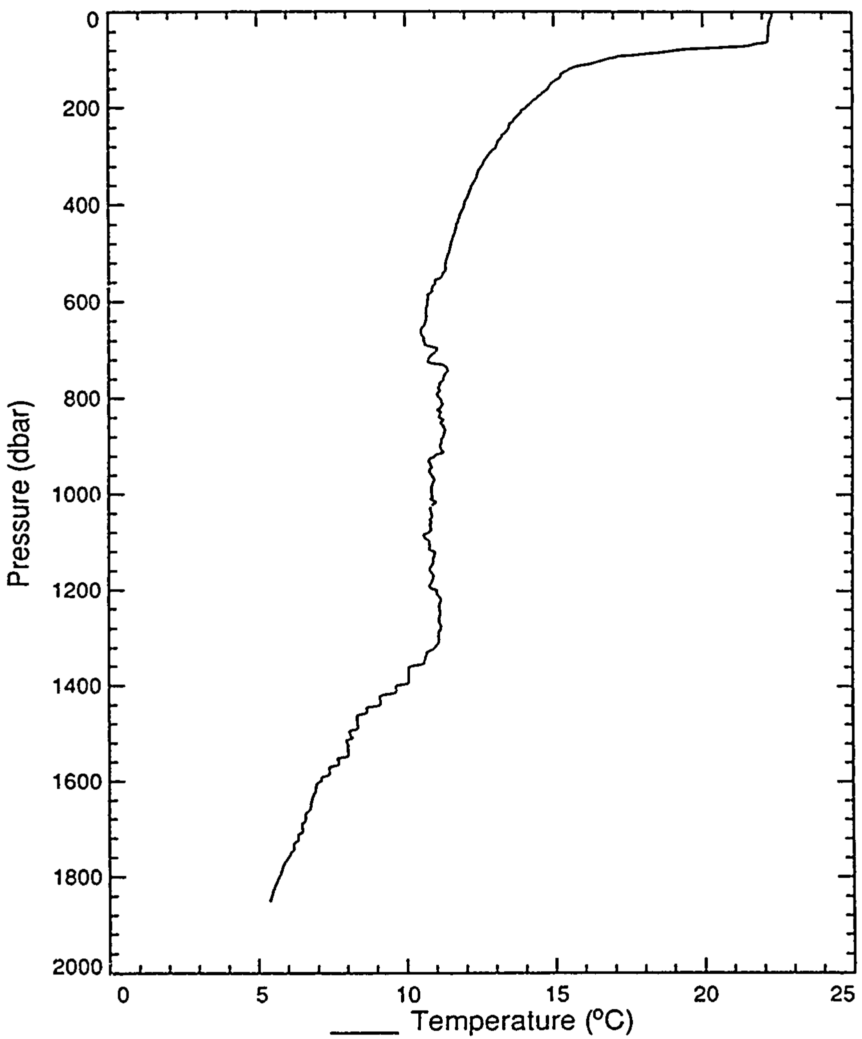
XBT 129



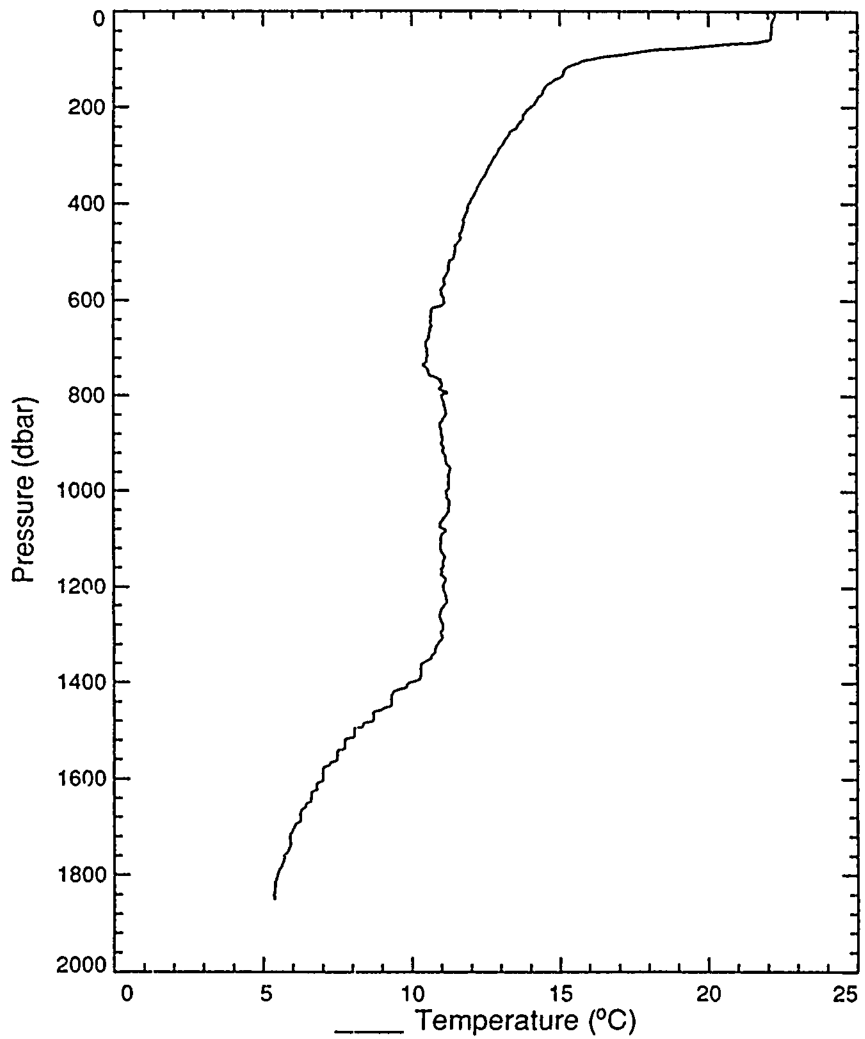
XBT 130



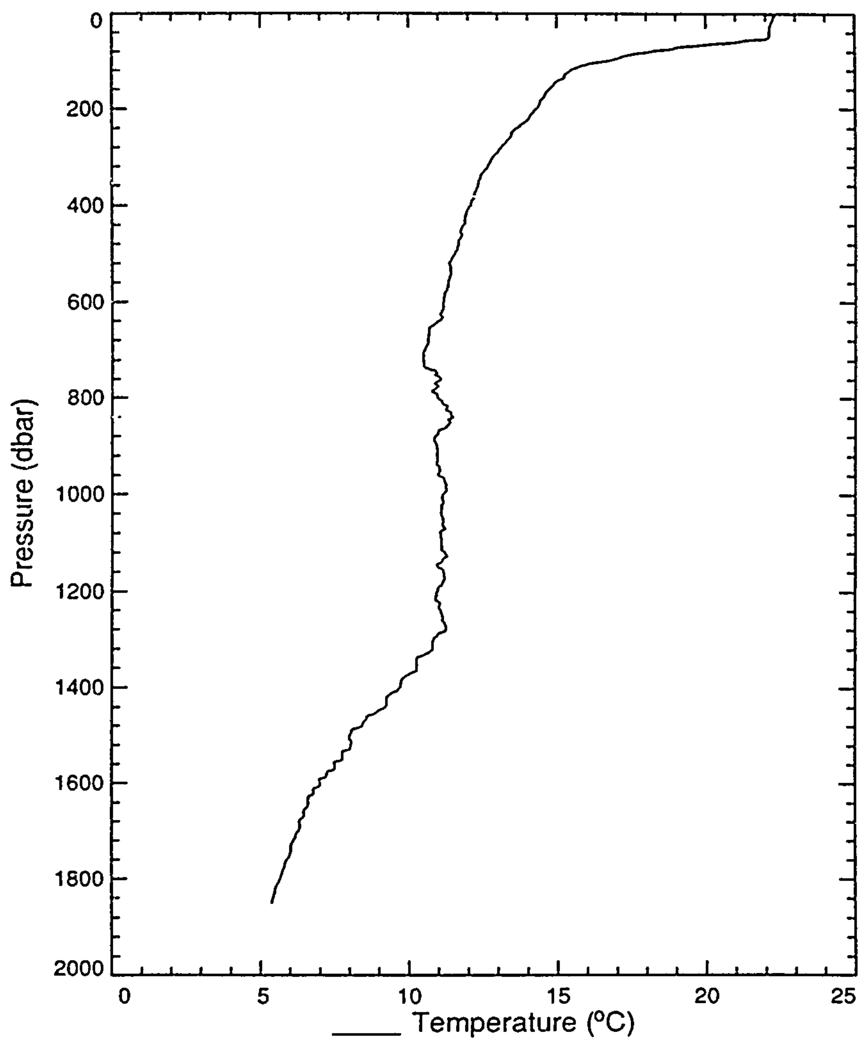
XBT 131



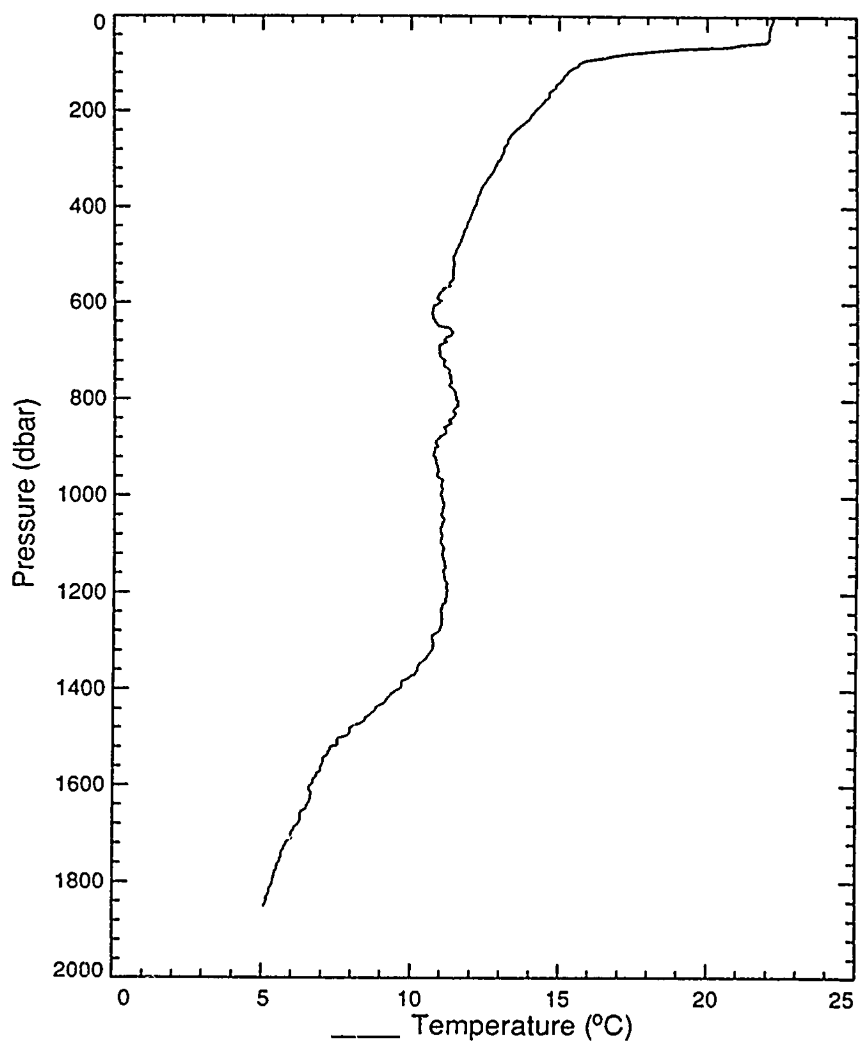
XBT 132



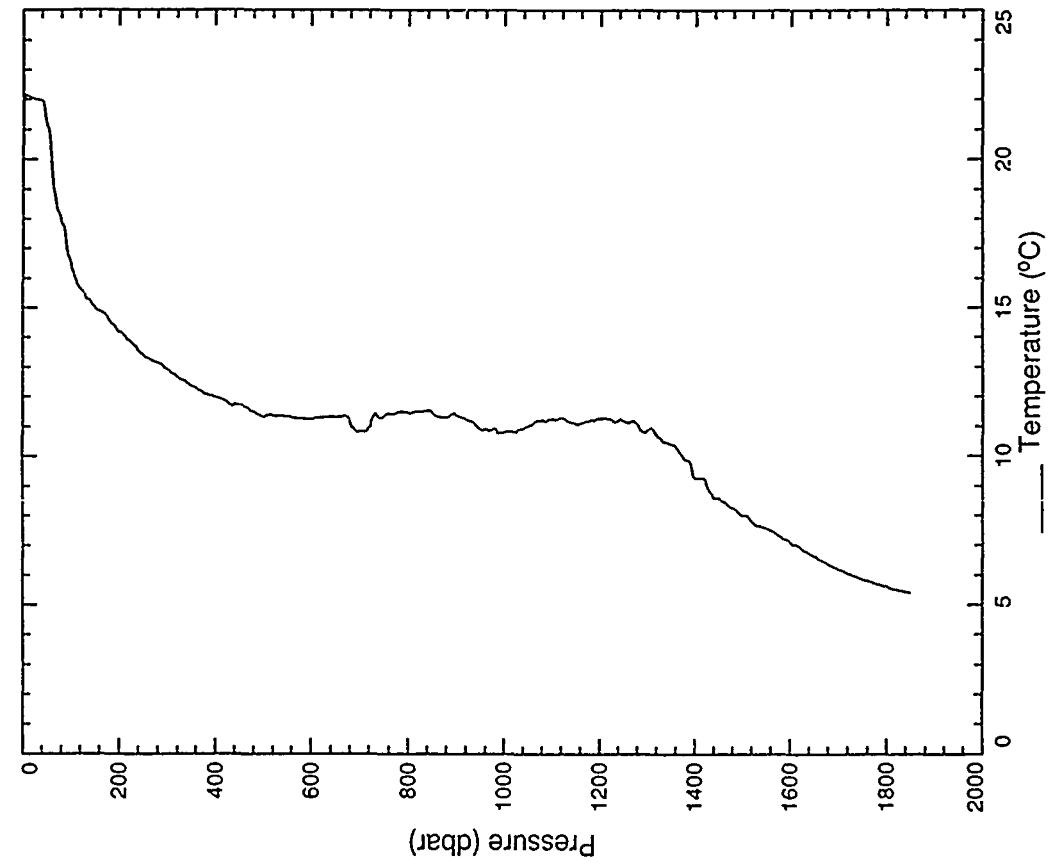
XBT 133



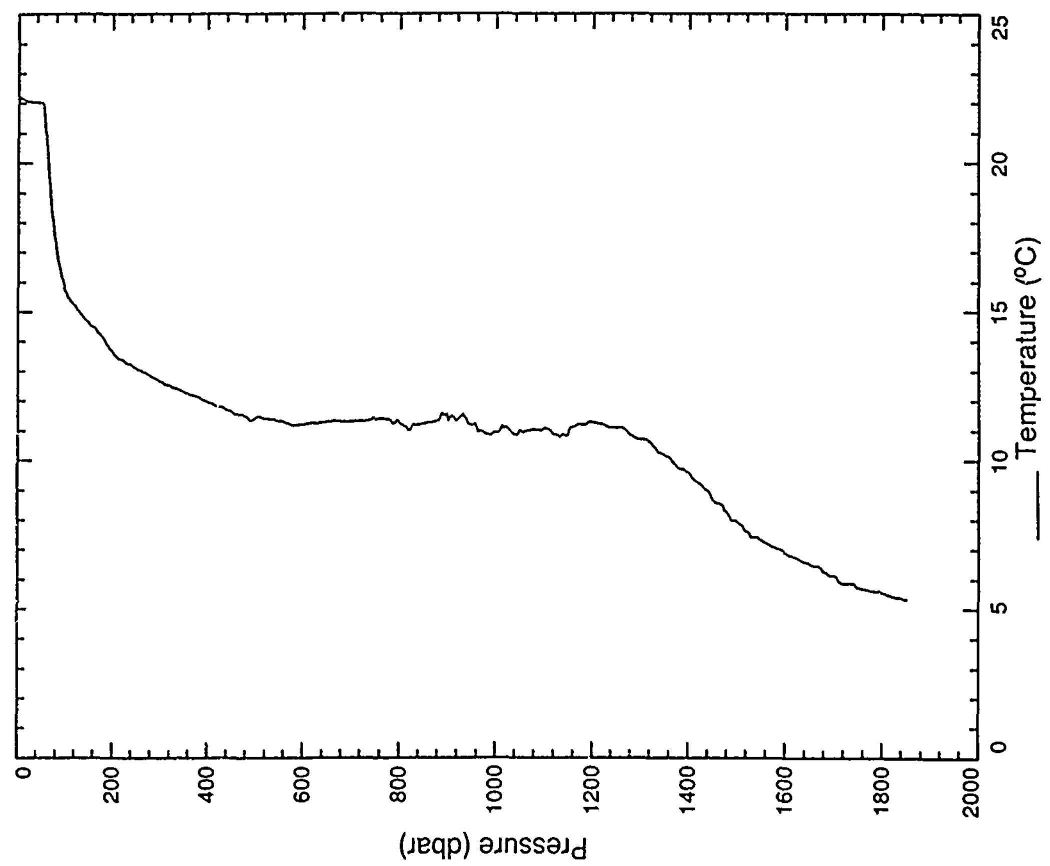
XBT 134

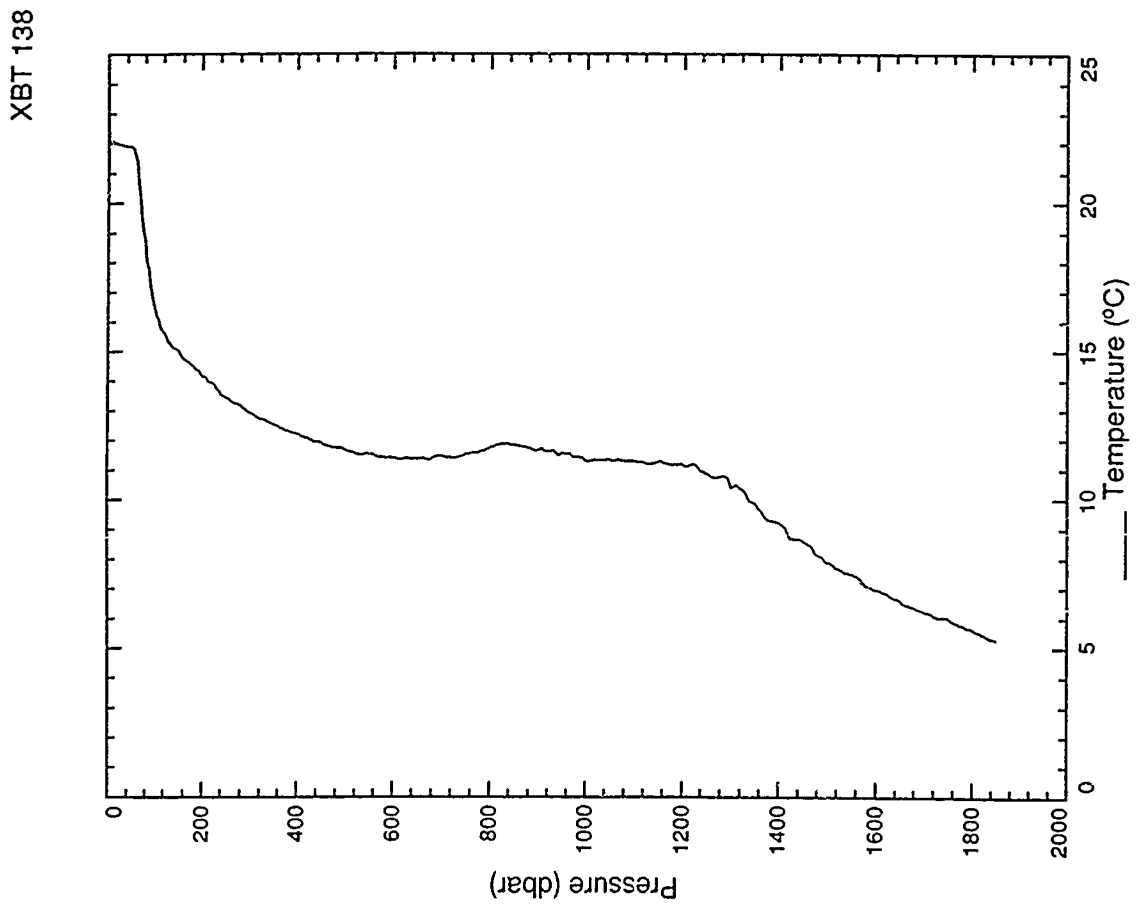


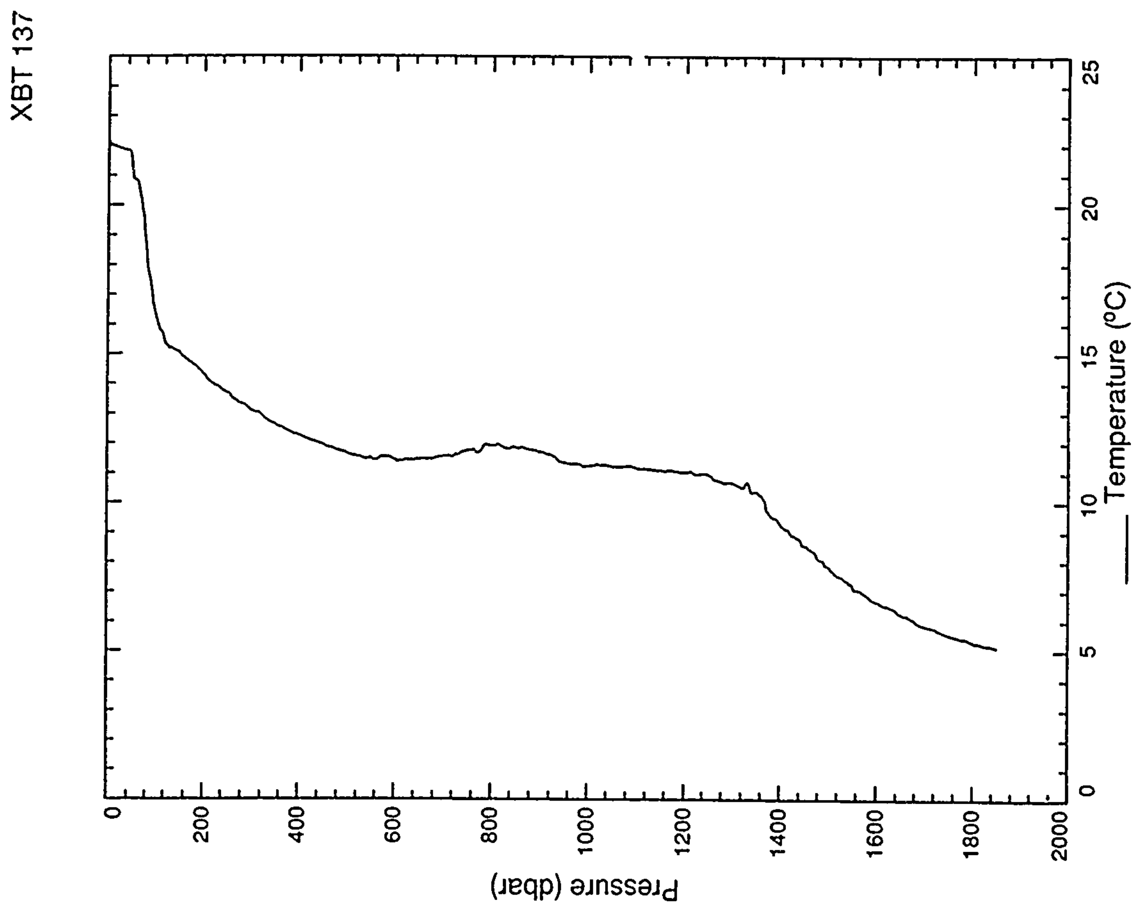
XBT 136



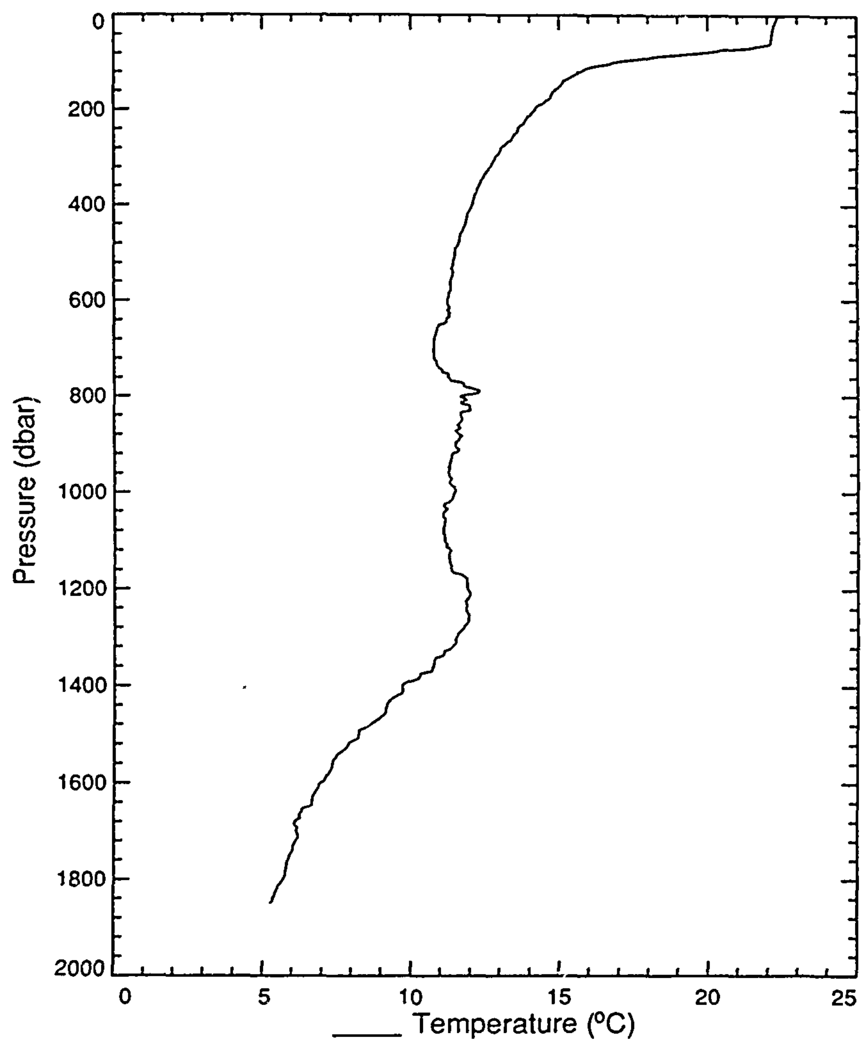
XBT 135



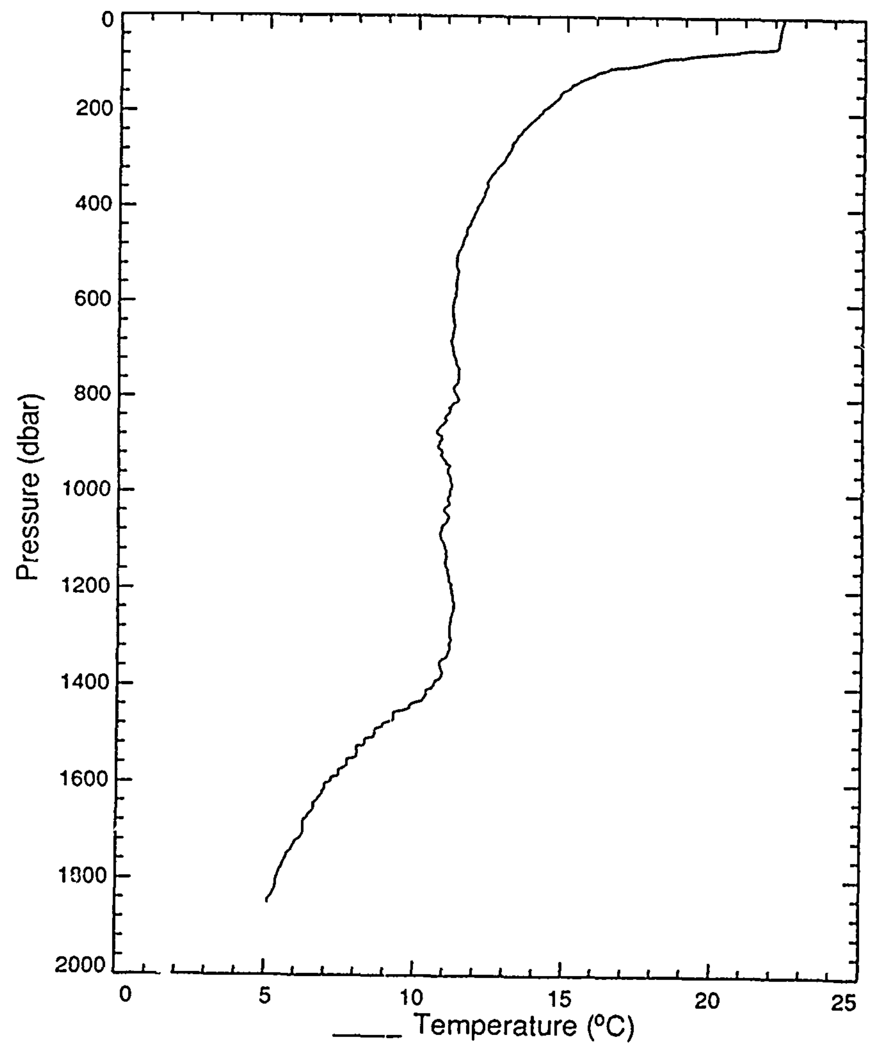

XBT 138
Temperature (ºC)
0
5
10
15
20
25
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000


XBT 137
Temperature (ºC)
0
5
10
15
20
25
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000

XBT 139



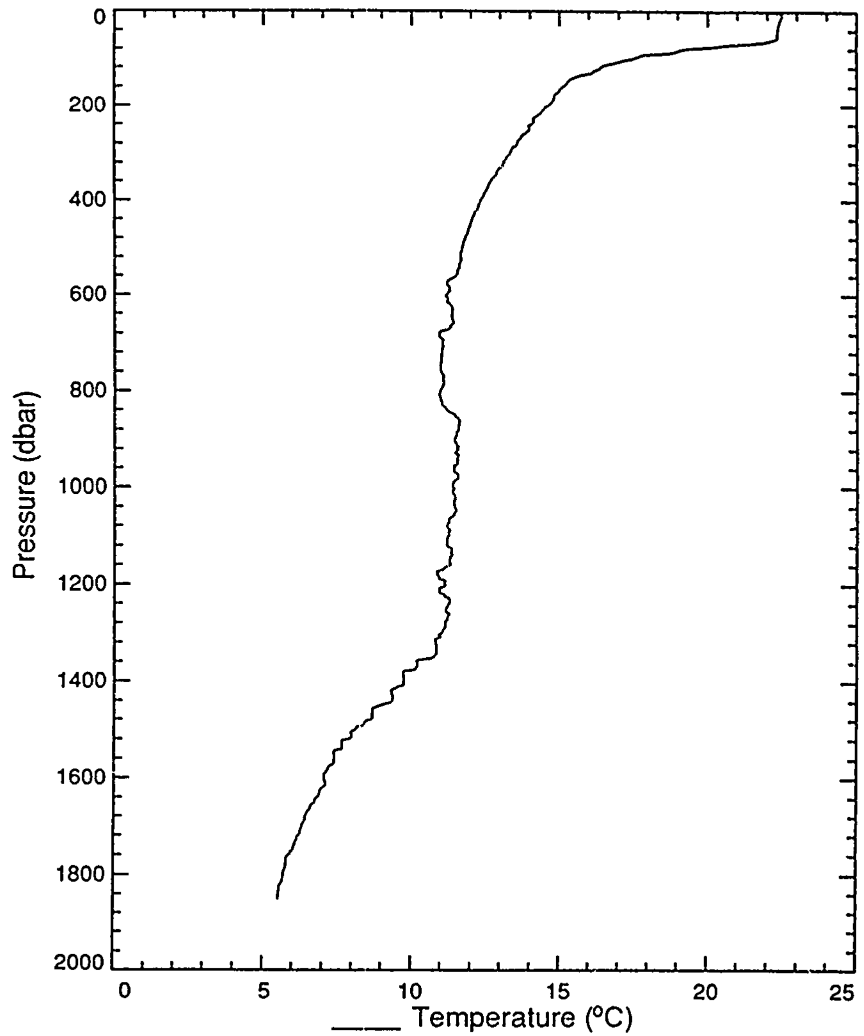
XBT 140



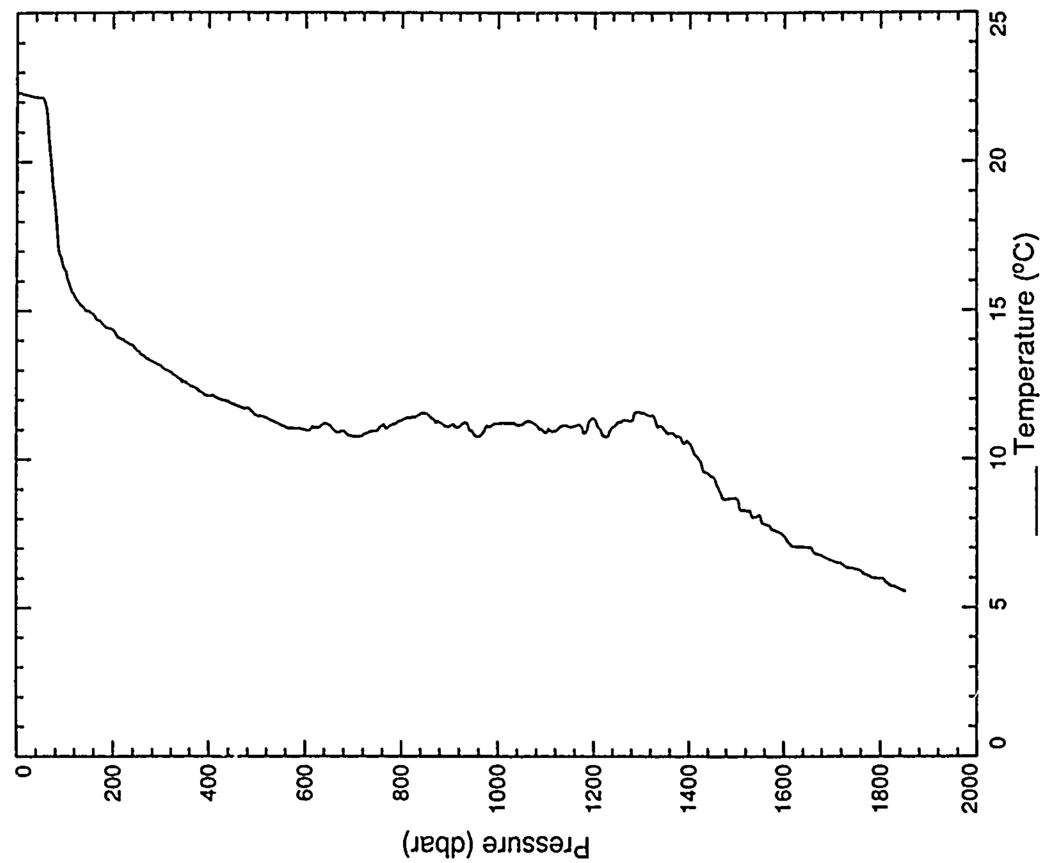
XBT 141

Off Scale

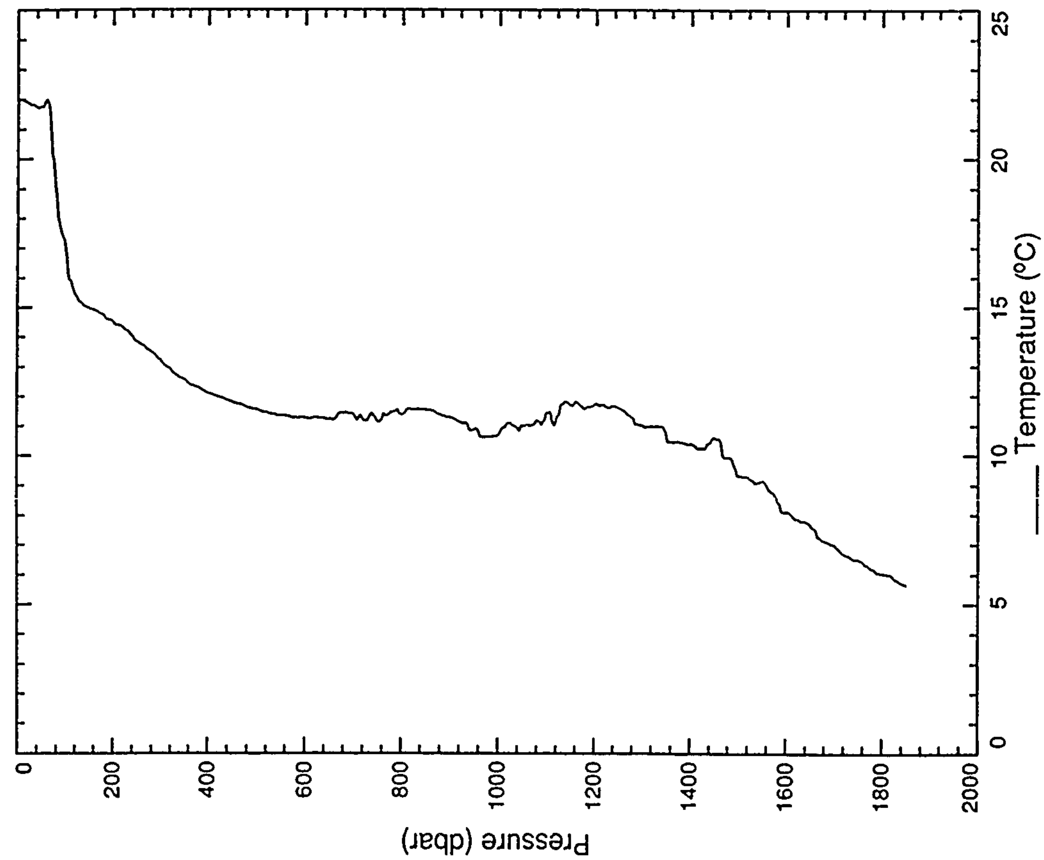
XBT 142

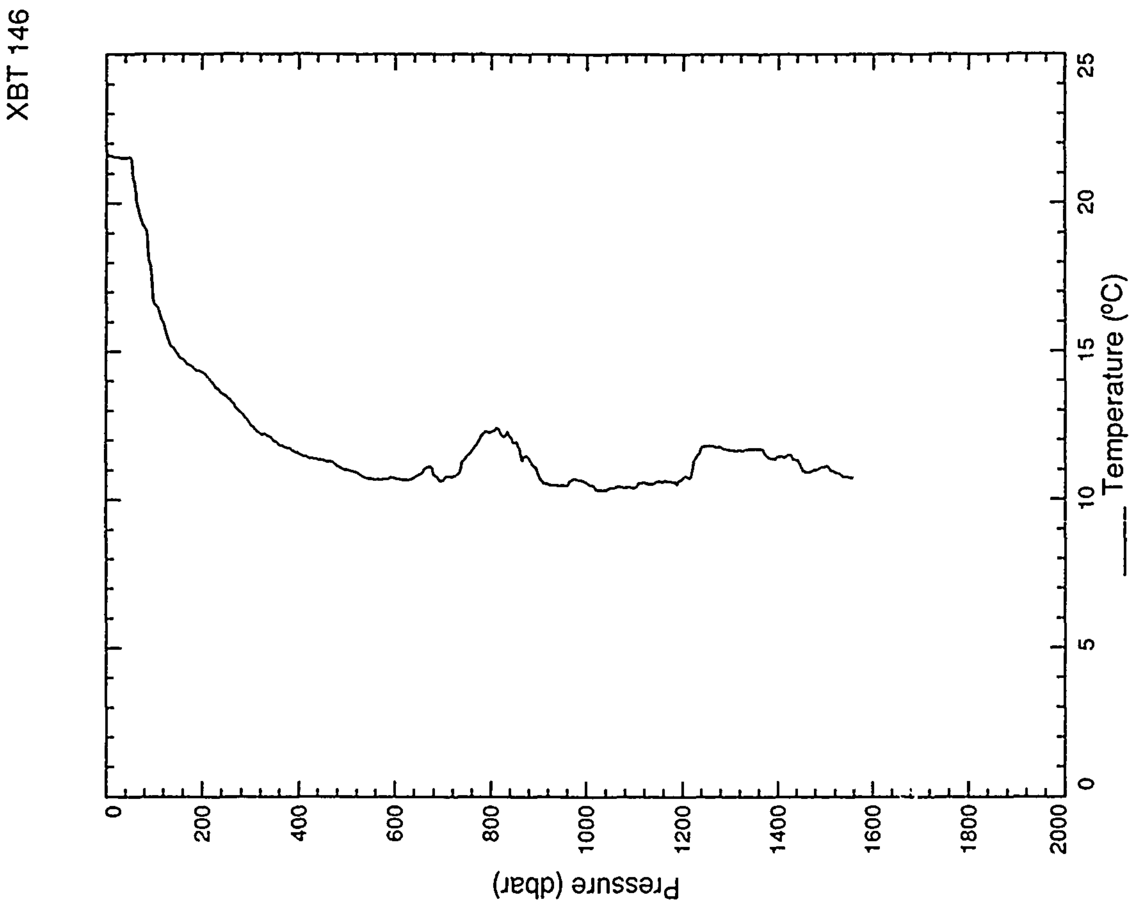


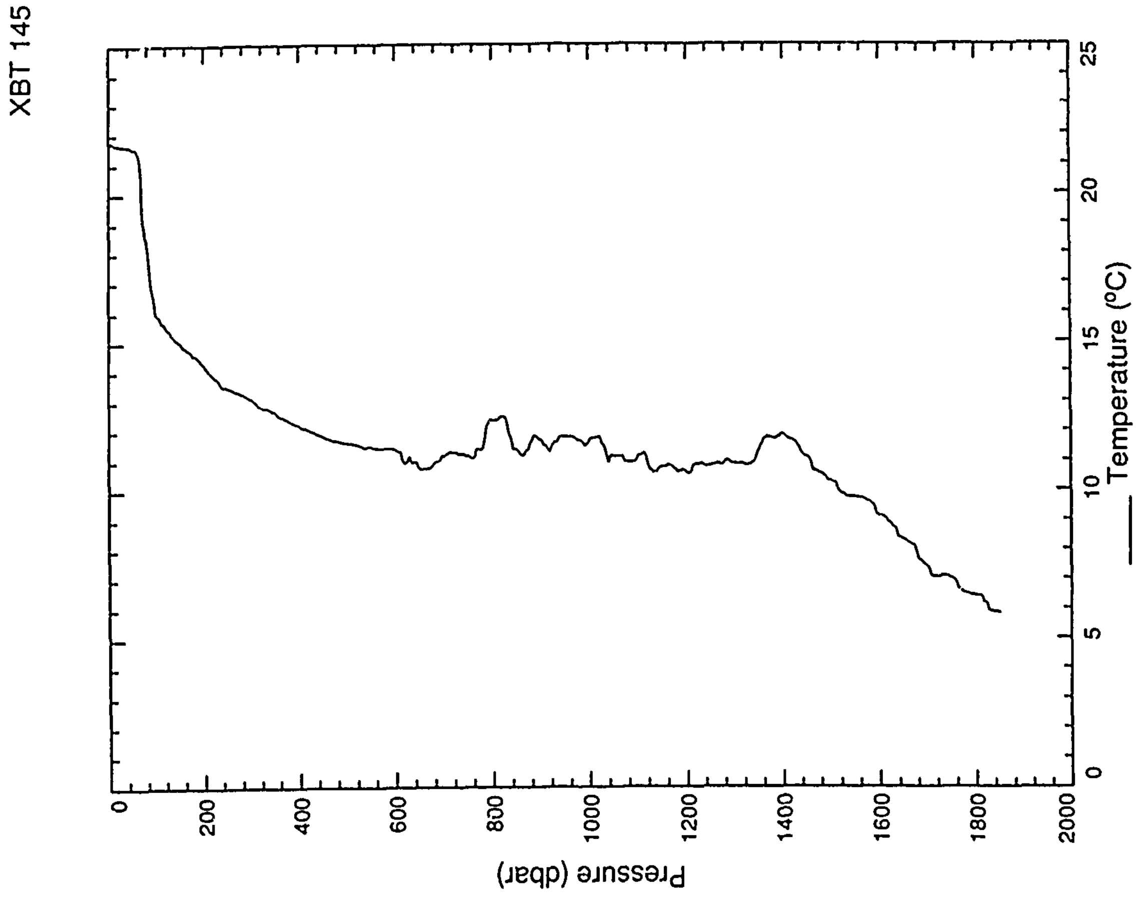
XBT 143



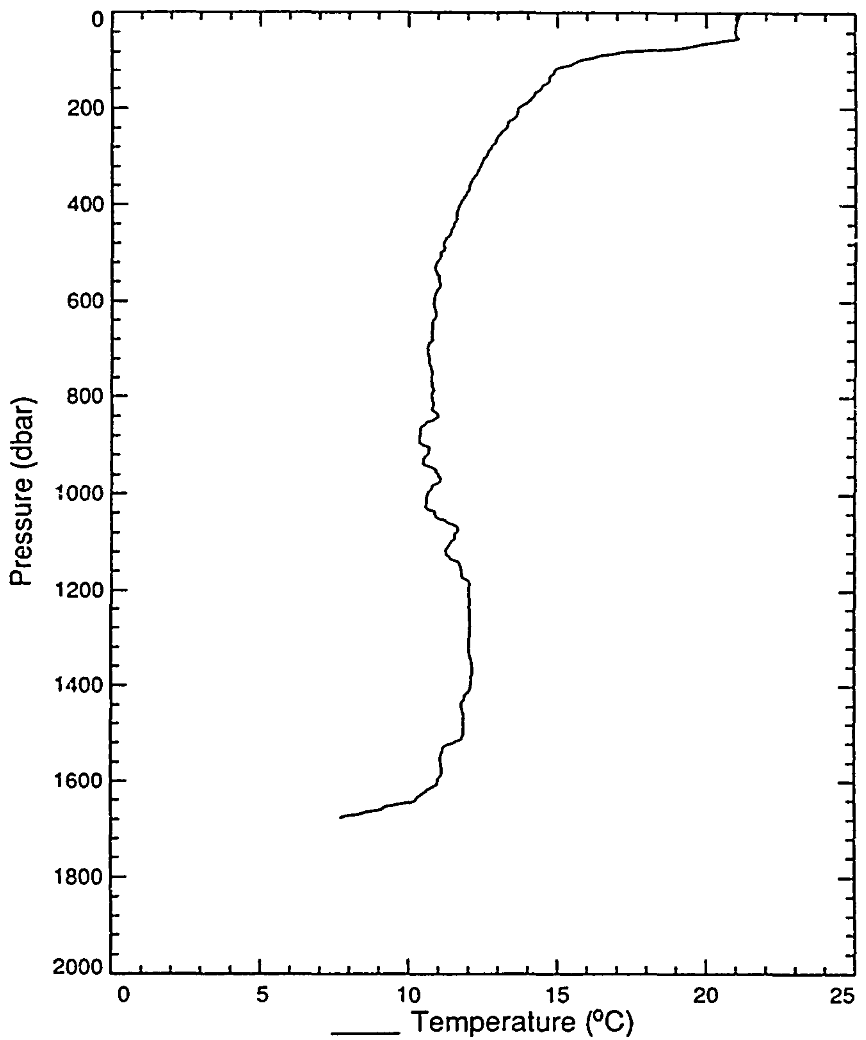
XBT 144



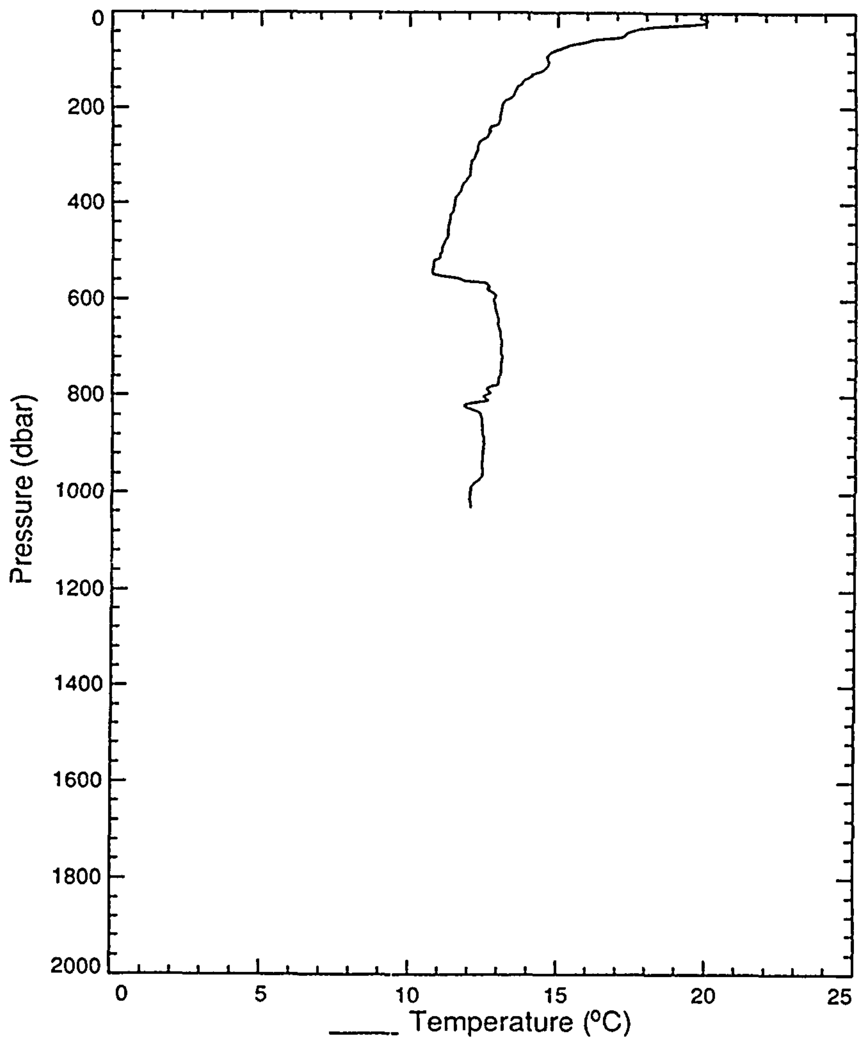

XBT 146
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 145
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

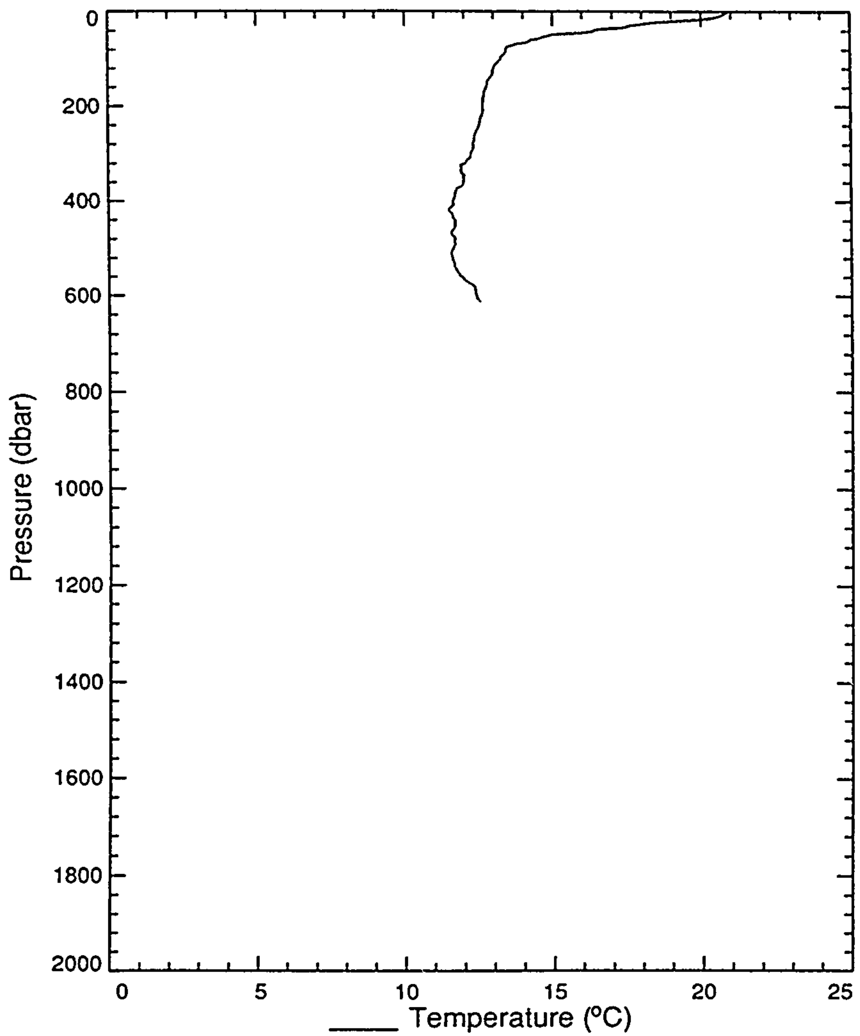
XBT 147



XBT 148



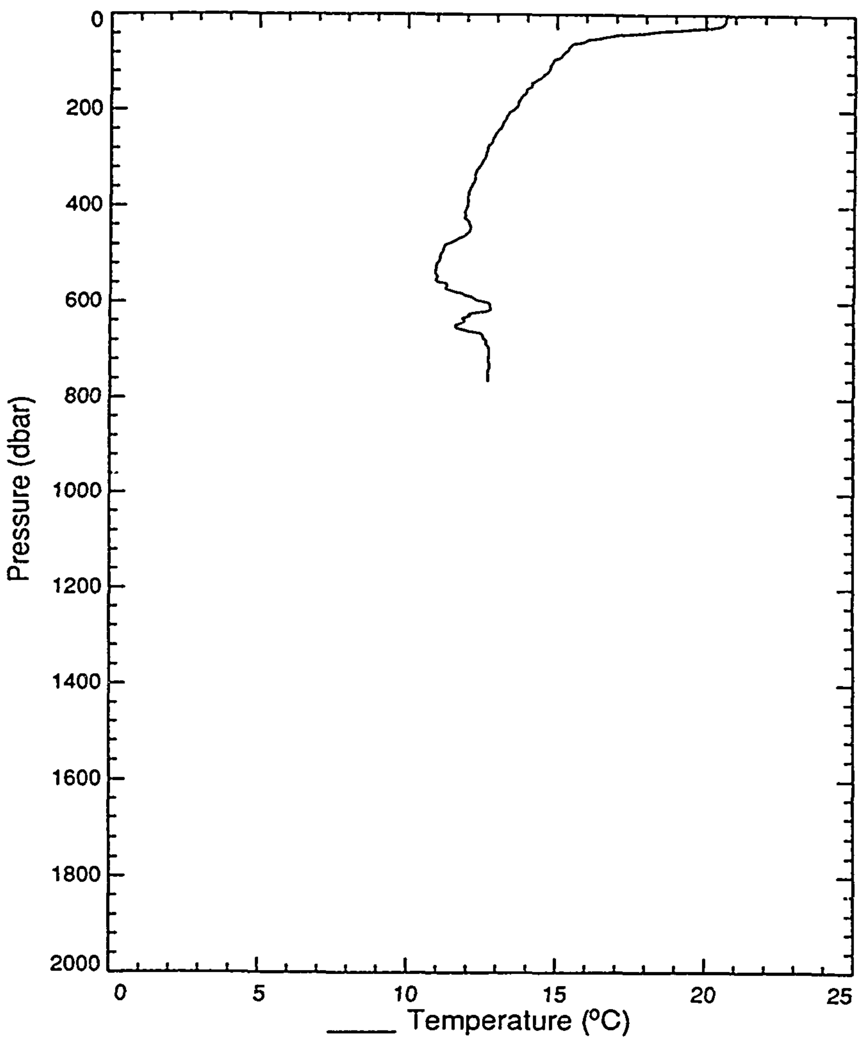
XBT 149



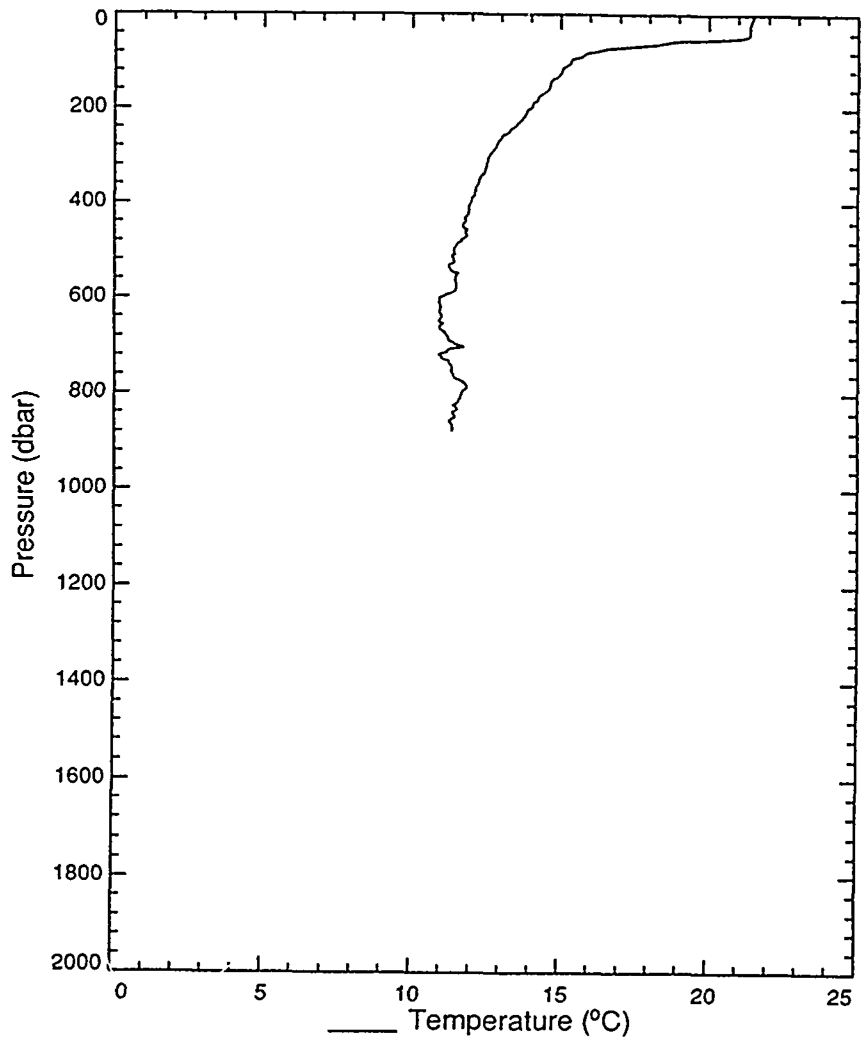
XBT 150

Bad Data

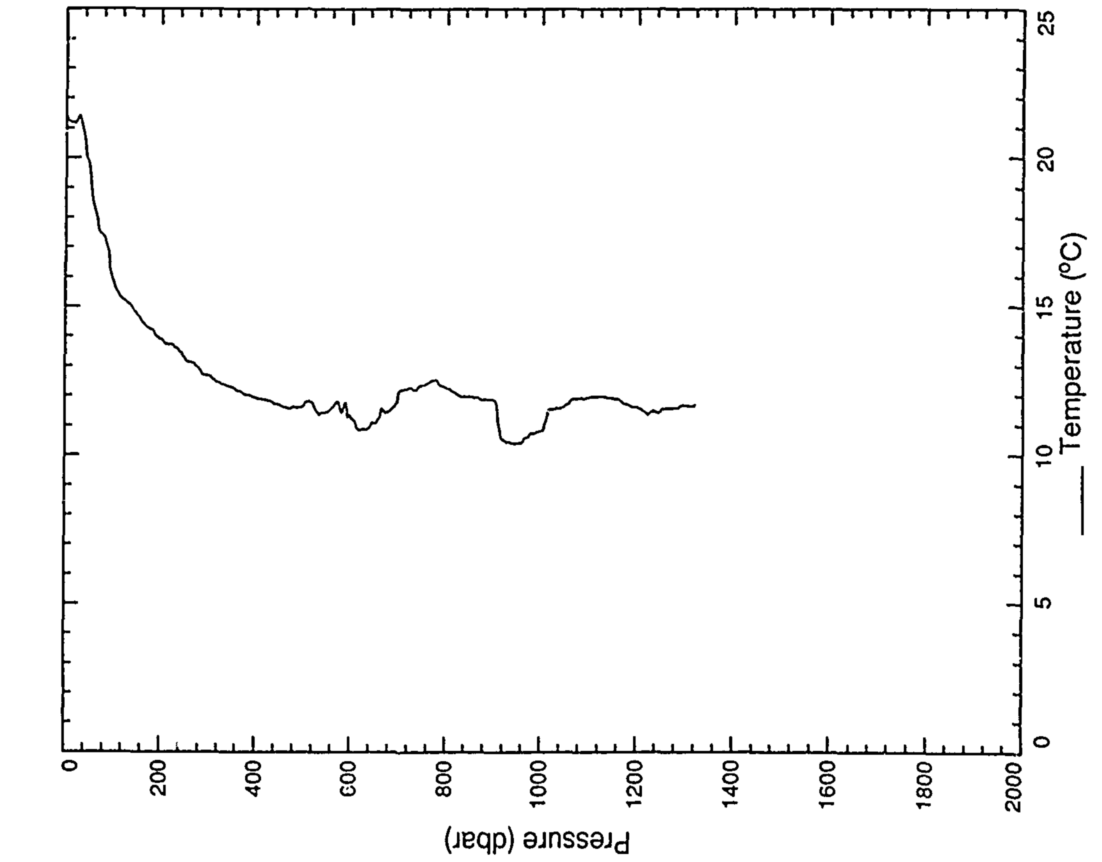
XBT 151



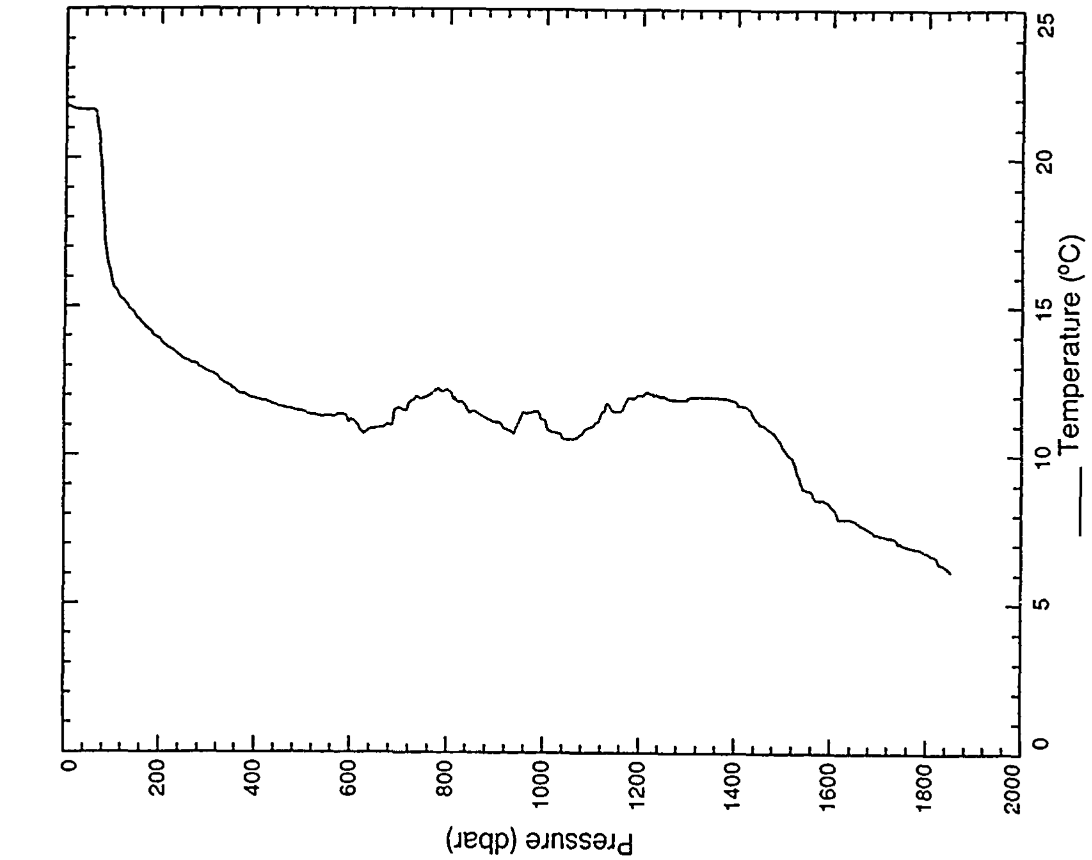
XBT 152



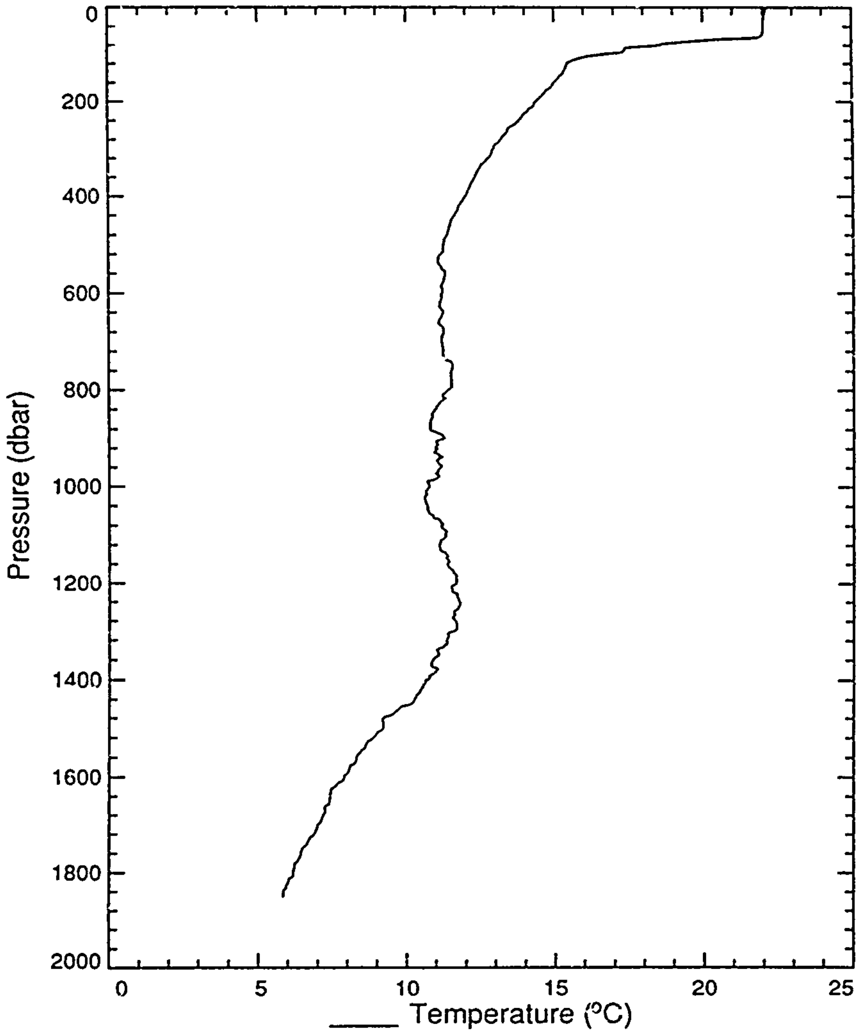
XBT 153



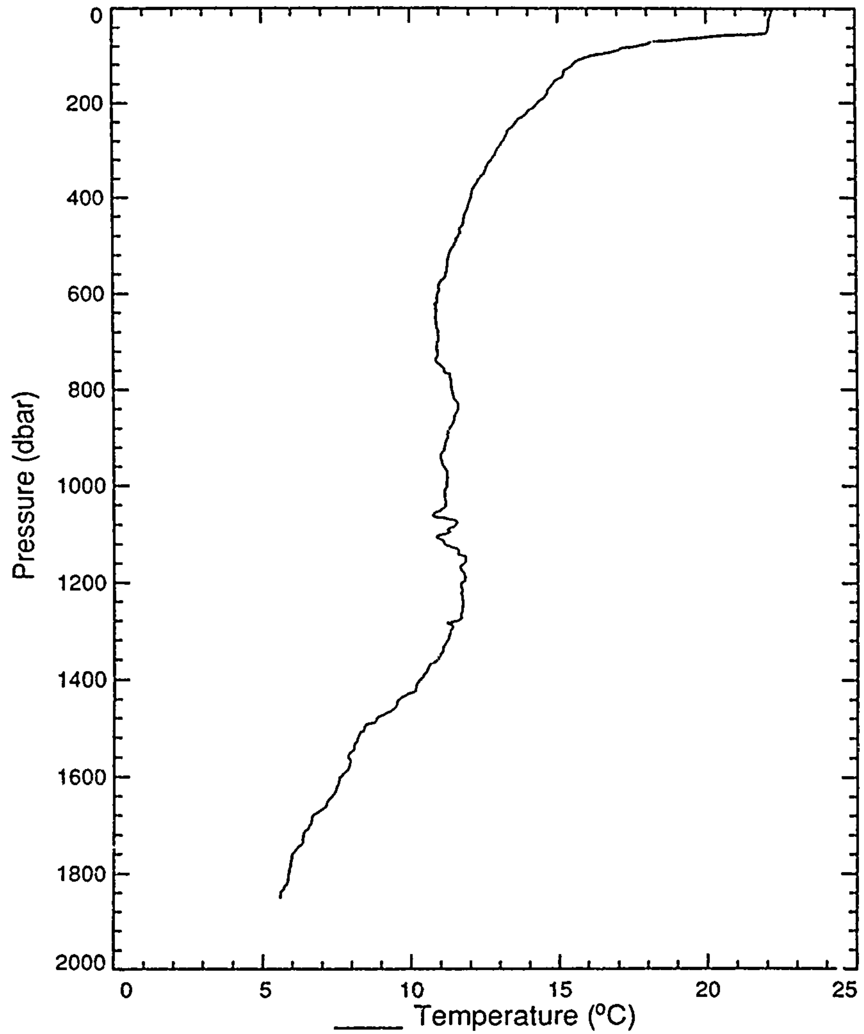
XBT 154

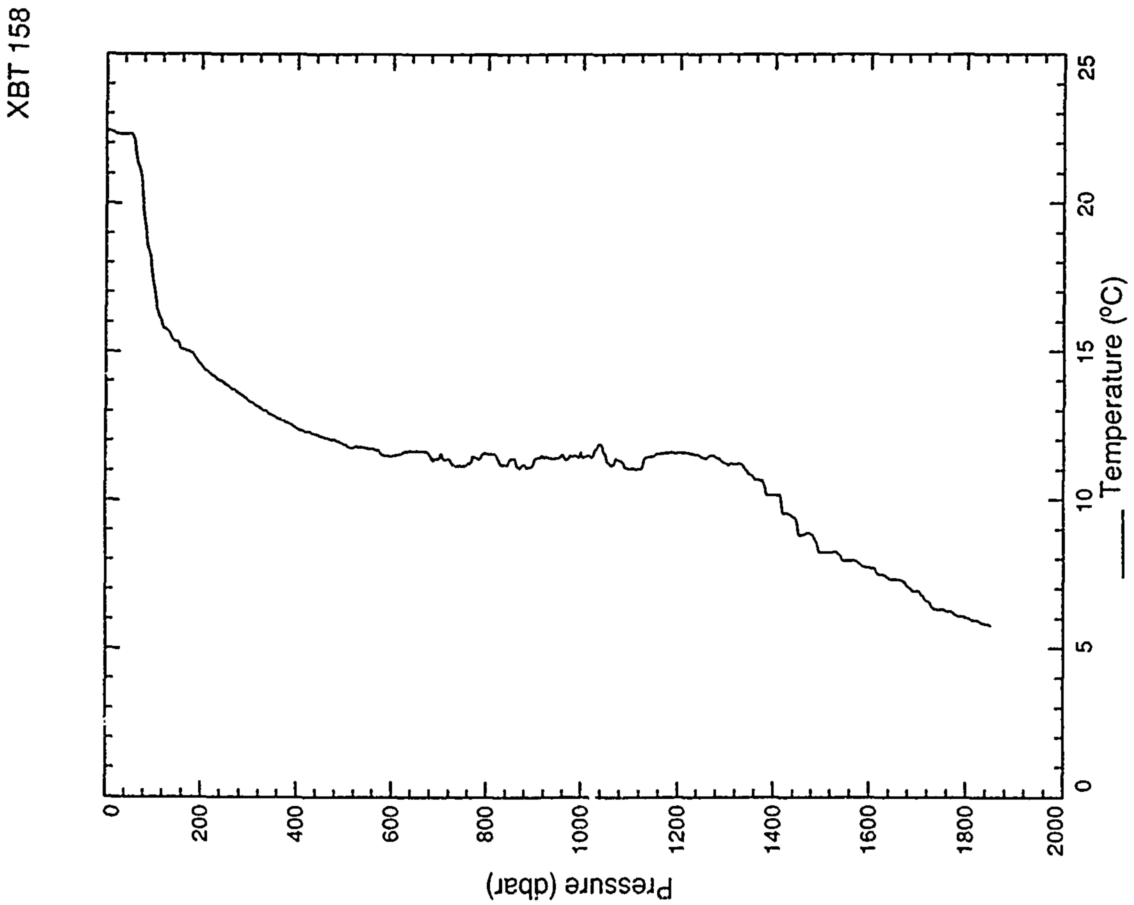


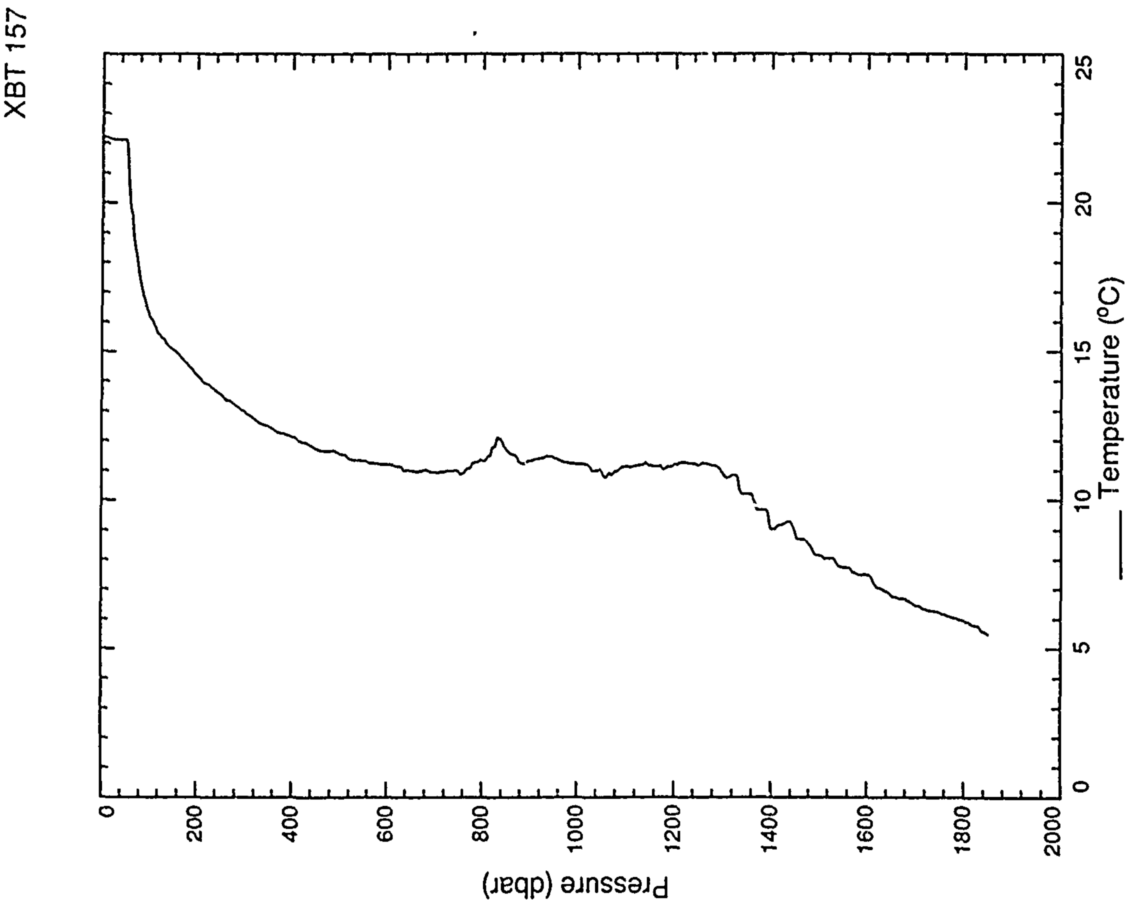
XBT 155



XBT 156




XBT 158
Pressure (dbar)
Temperature (°C)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25


XBT 157
Pressure (dbar)
Temperature (°C)
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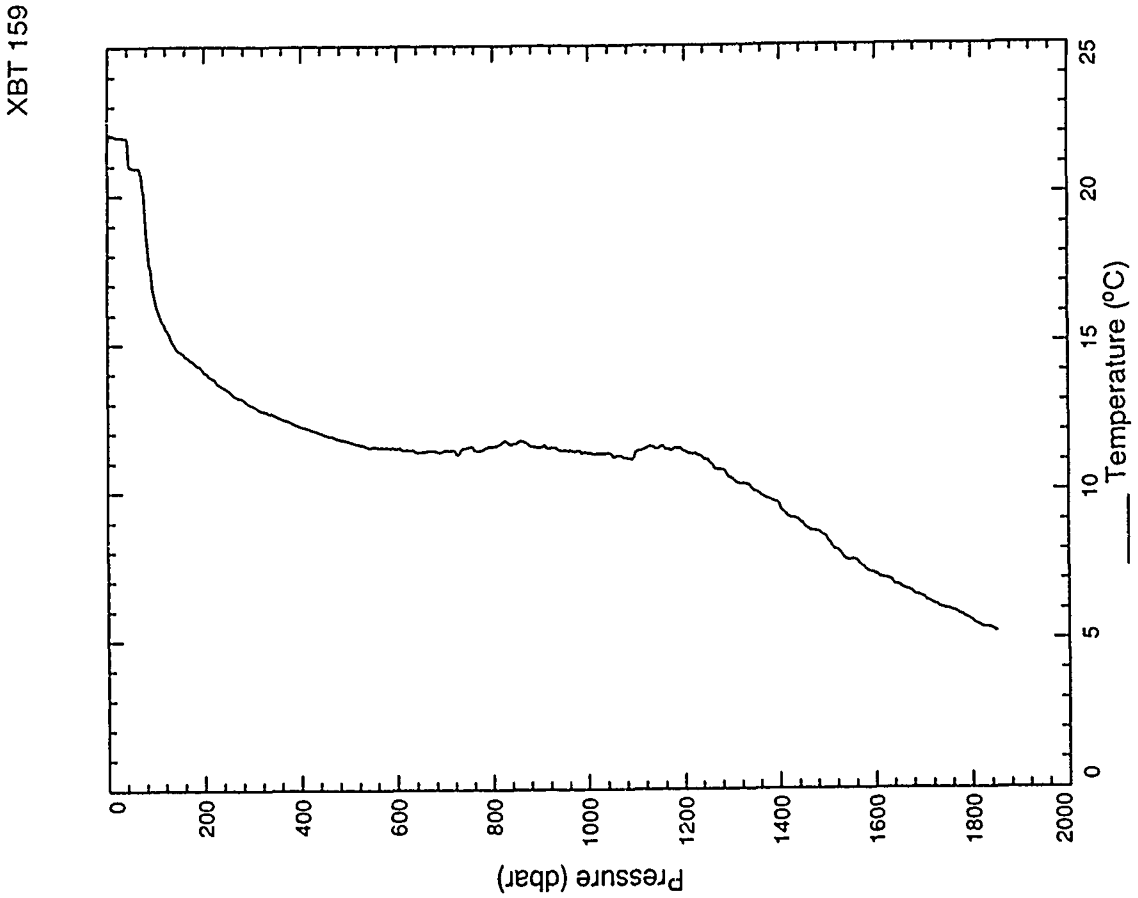
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25



XBT 159
Pressure (dbar)
0
200
400
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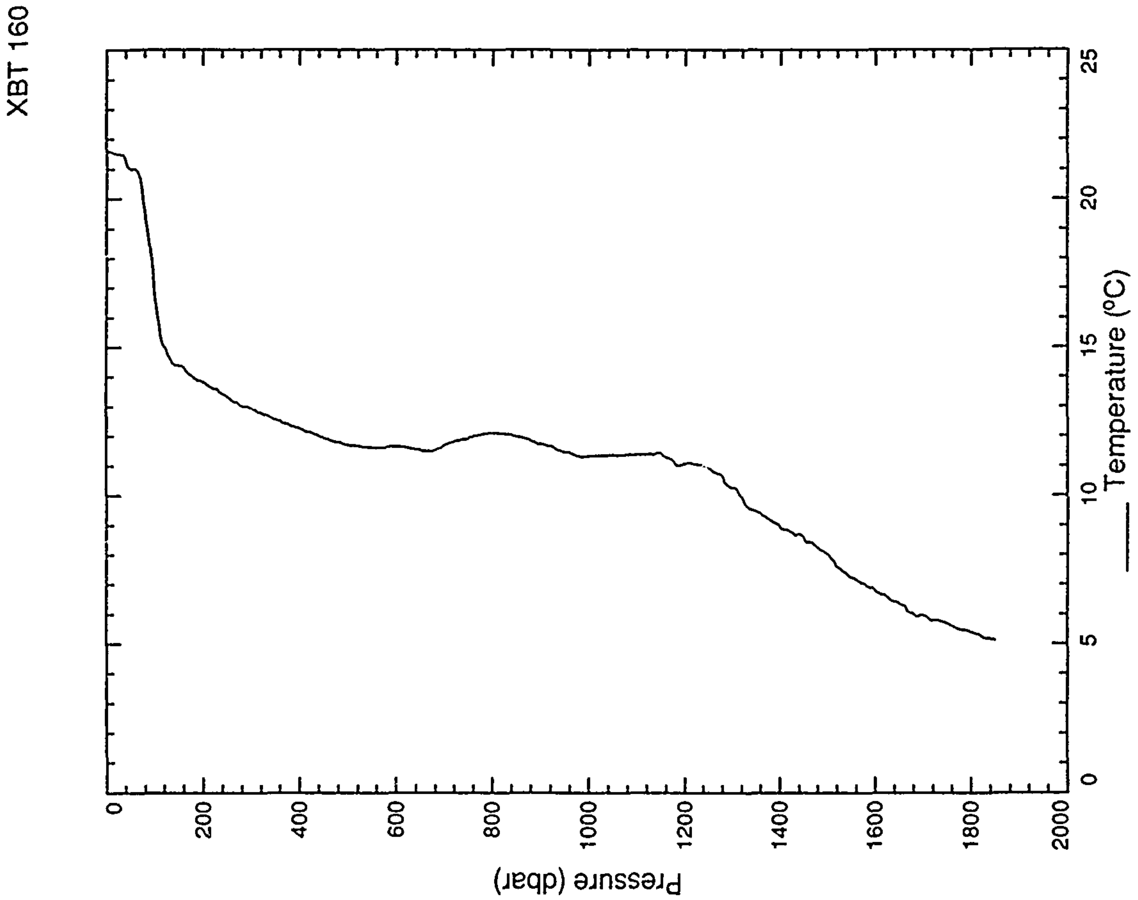
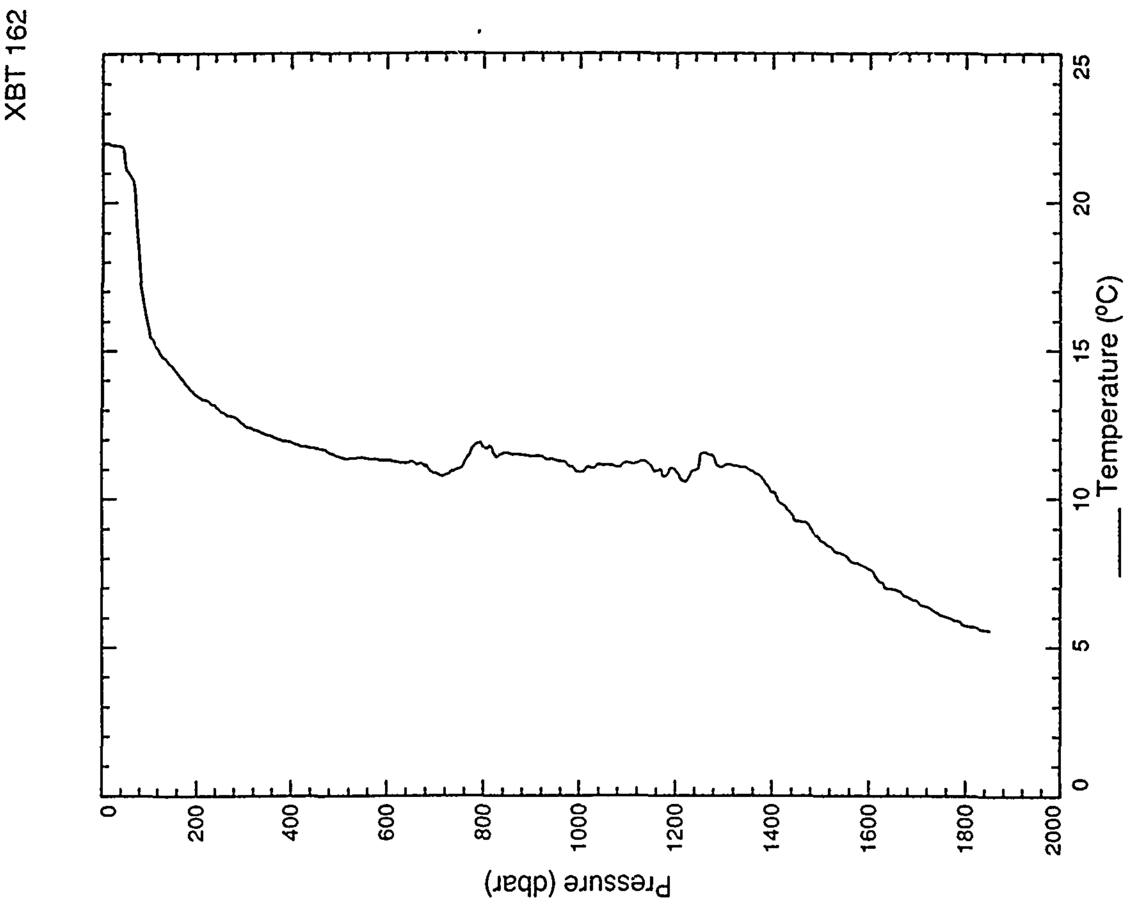
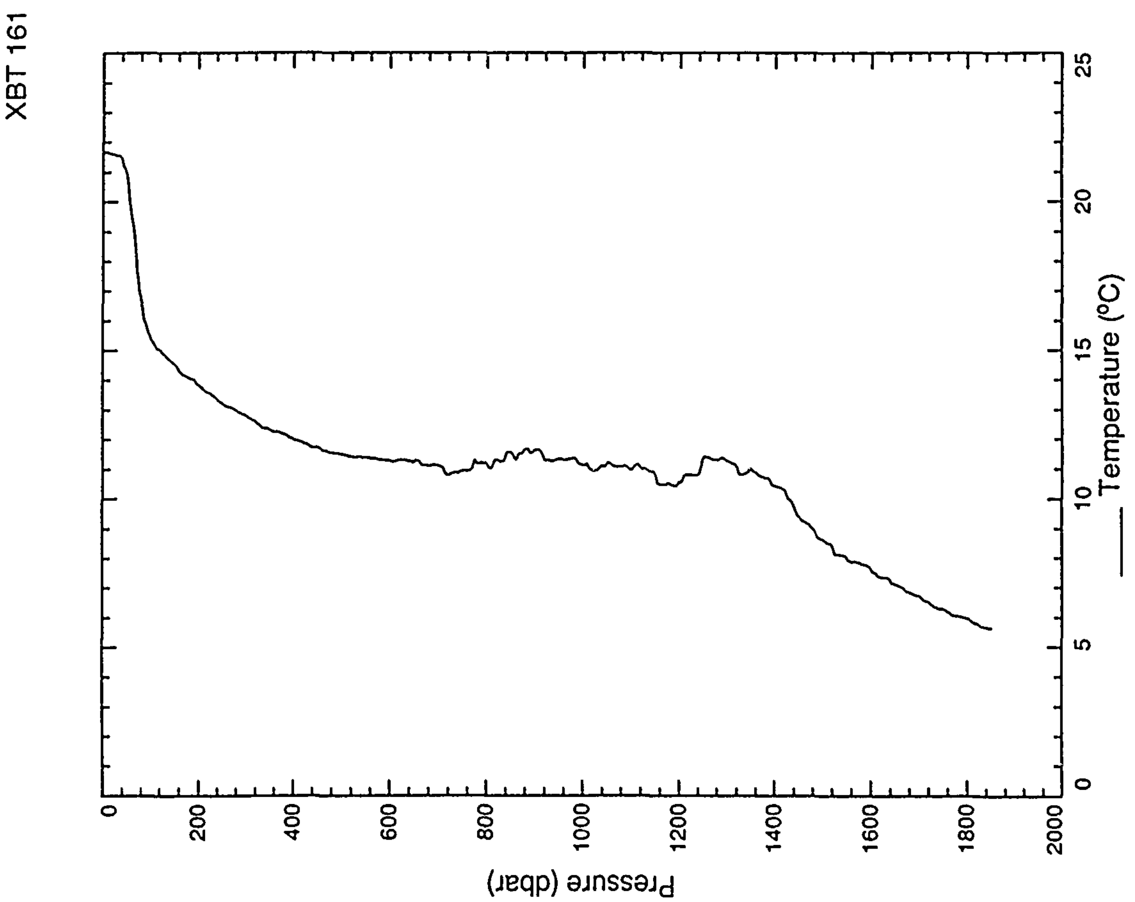
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (ºC)

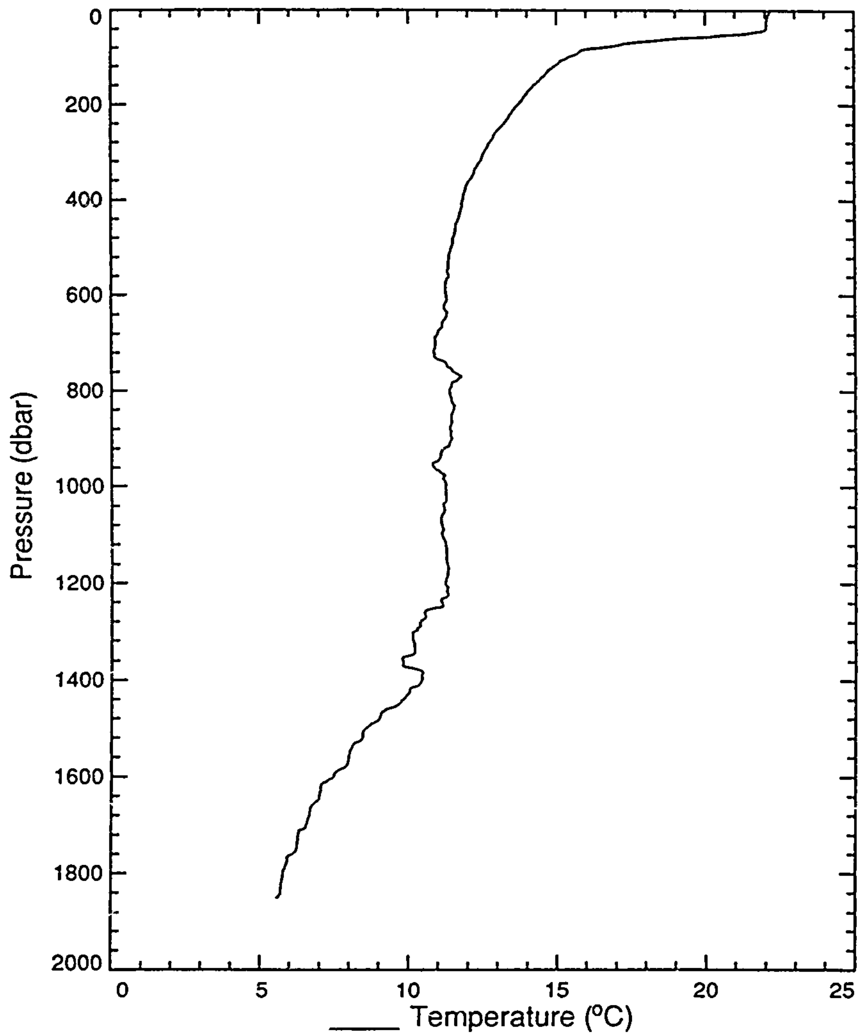


XBT 160
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (ºC)

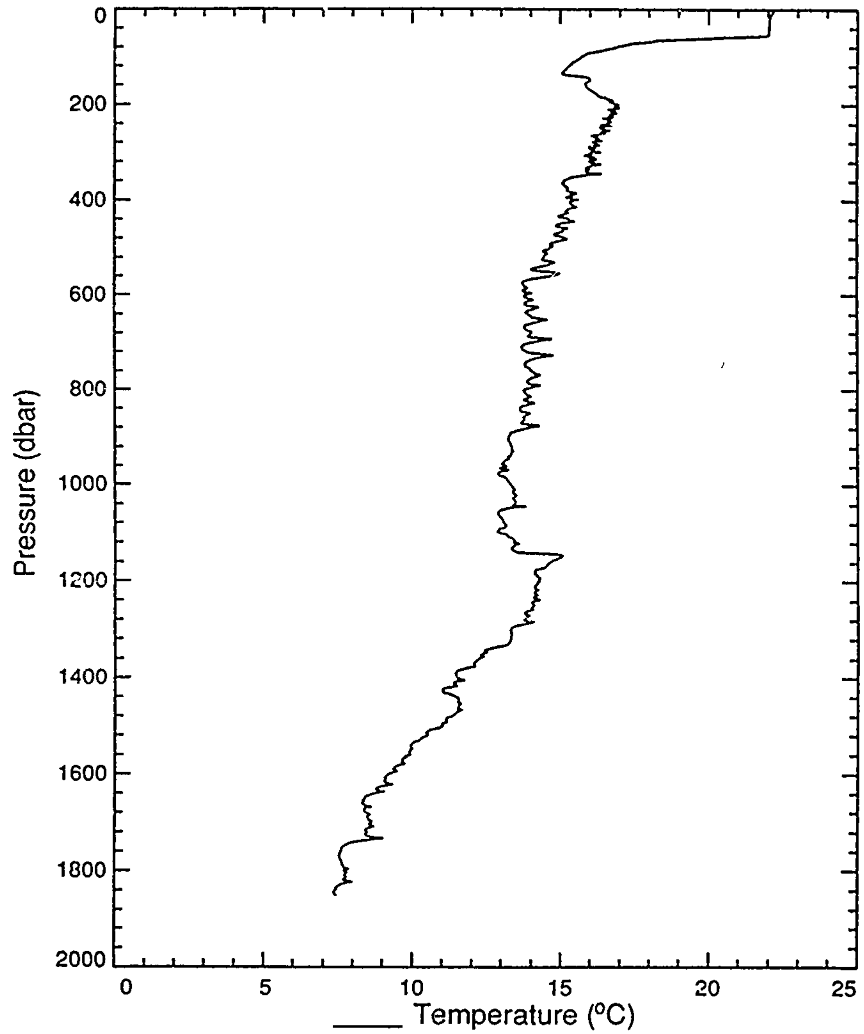

XBT 162
Pressure (dbar)
Temperature (ºC)

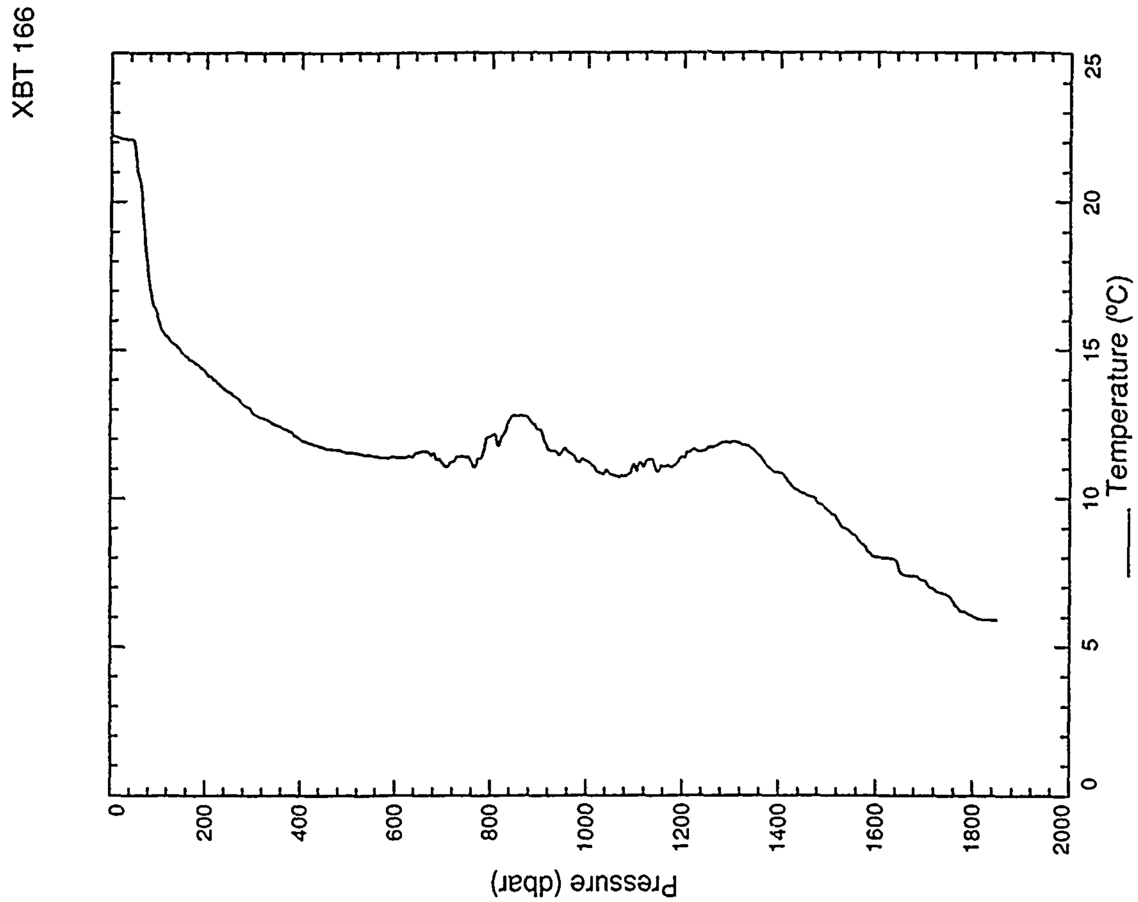

XBT 161
Pressure (dbar)
Temperature (ºC)

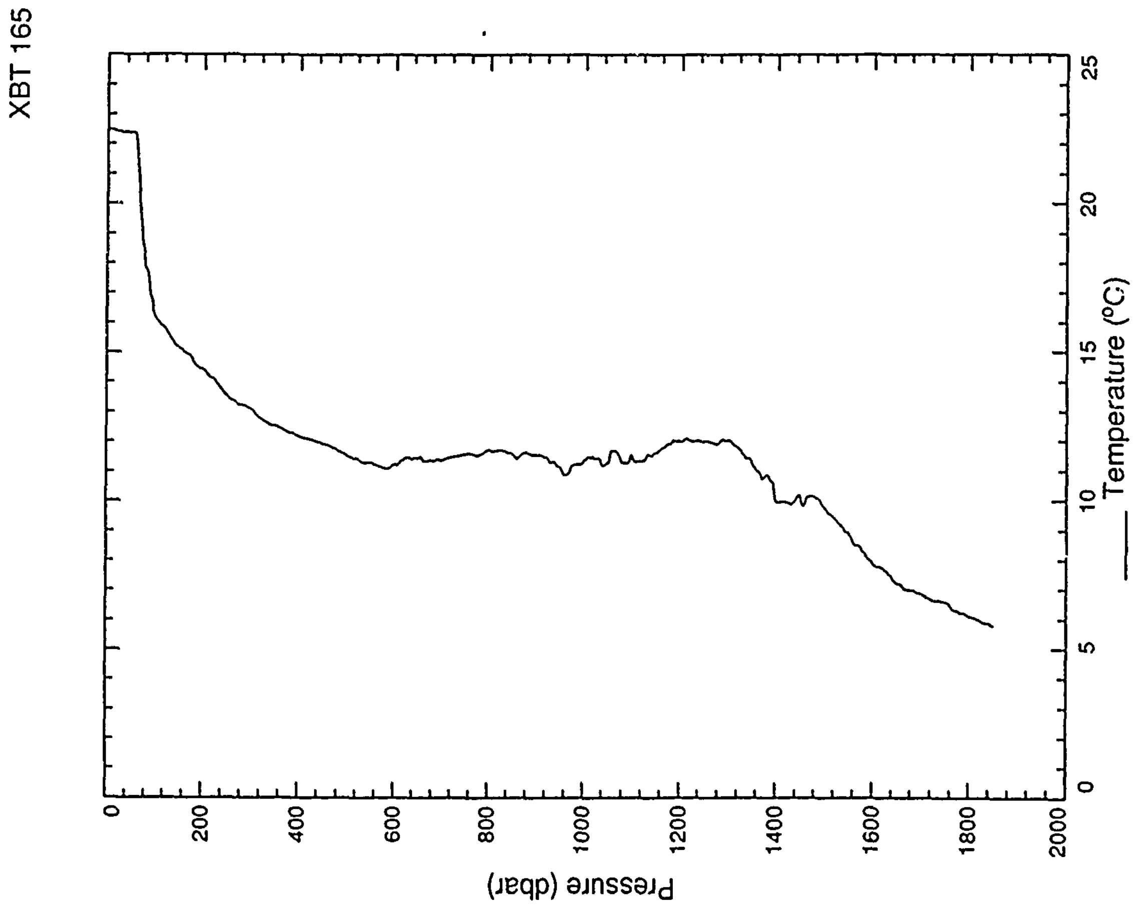
XBT 163



XBT 164




XBT 166
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25


XBT 165
Pressure (dbar)
0
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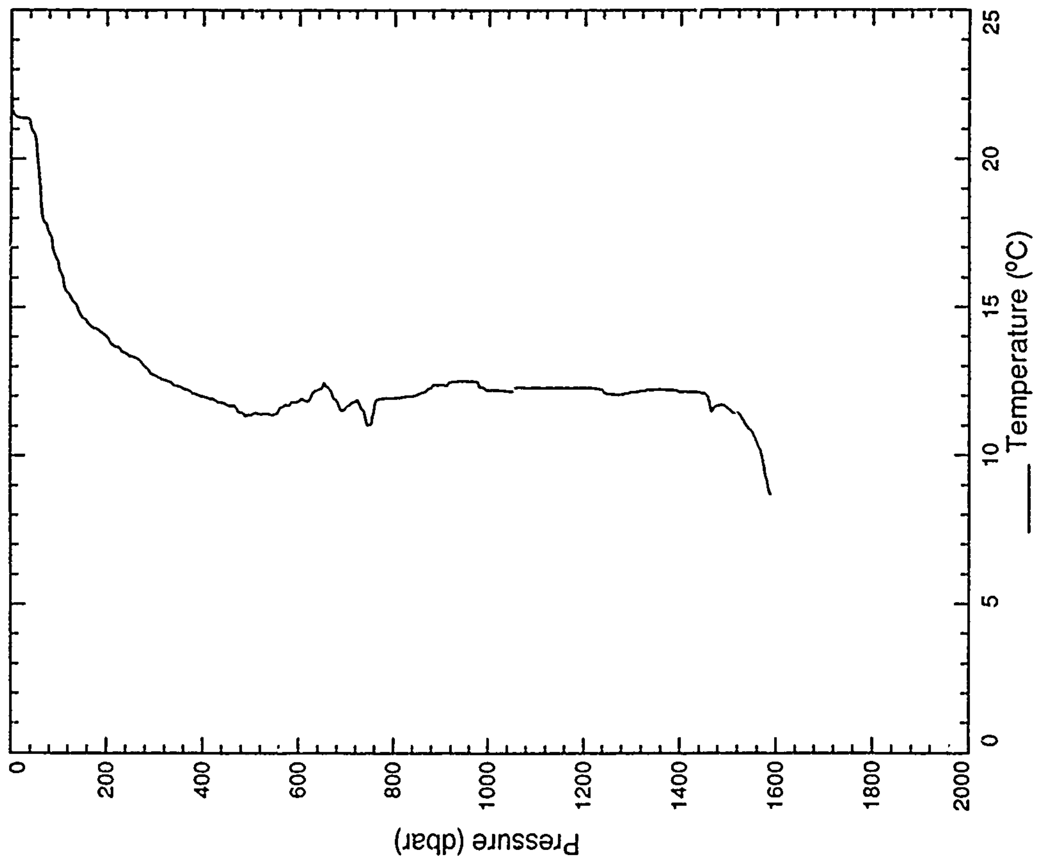
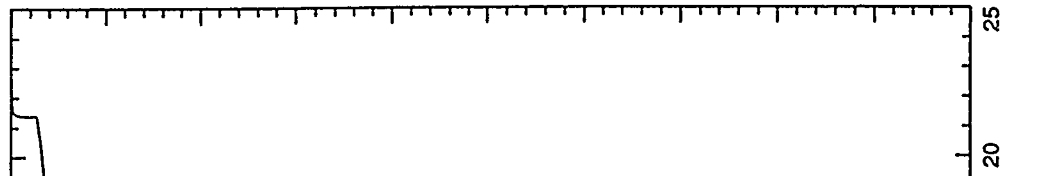
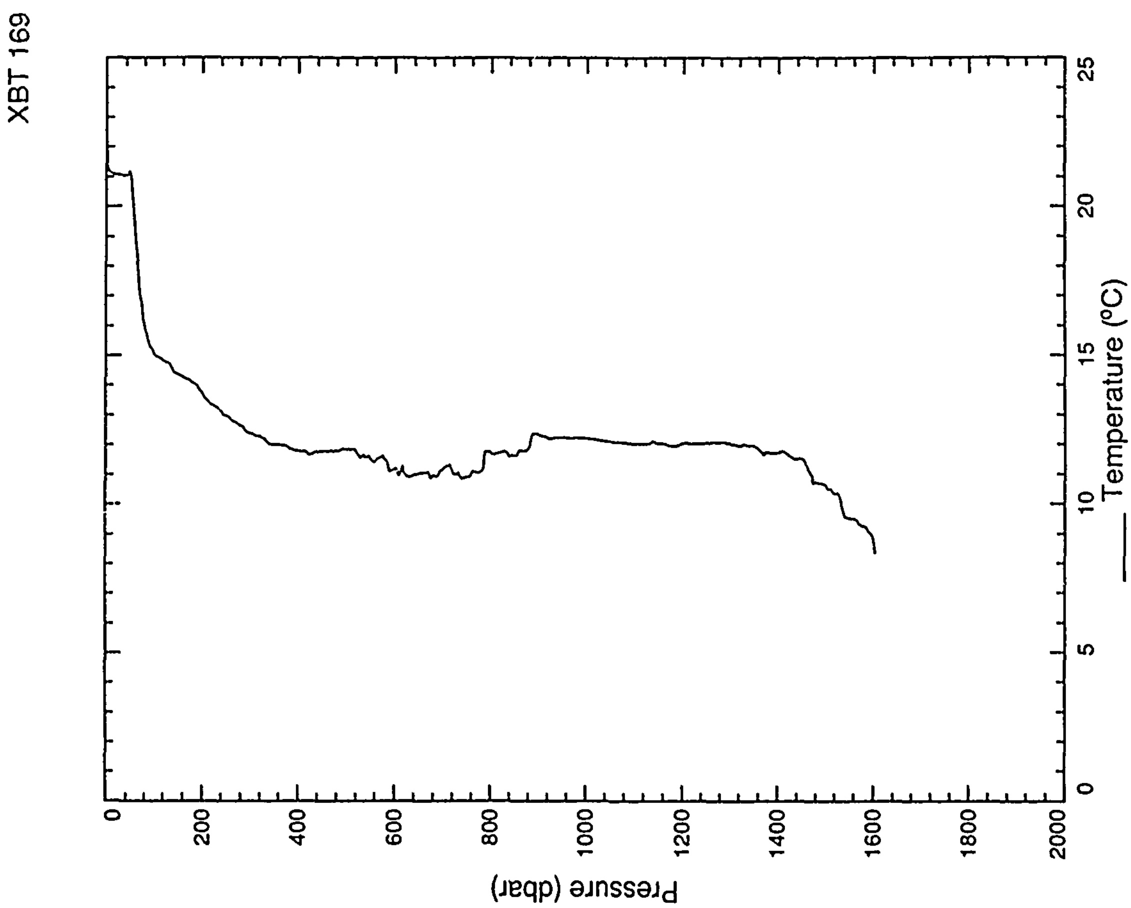
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25

XBT 168



XBT 167




XBT 169
Pressure (dbar)
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200
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1800
2000
Temperature (ºC)
0
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10
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20
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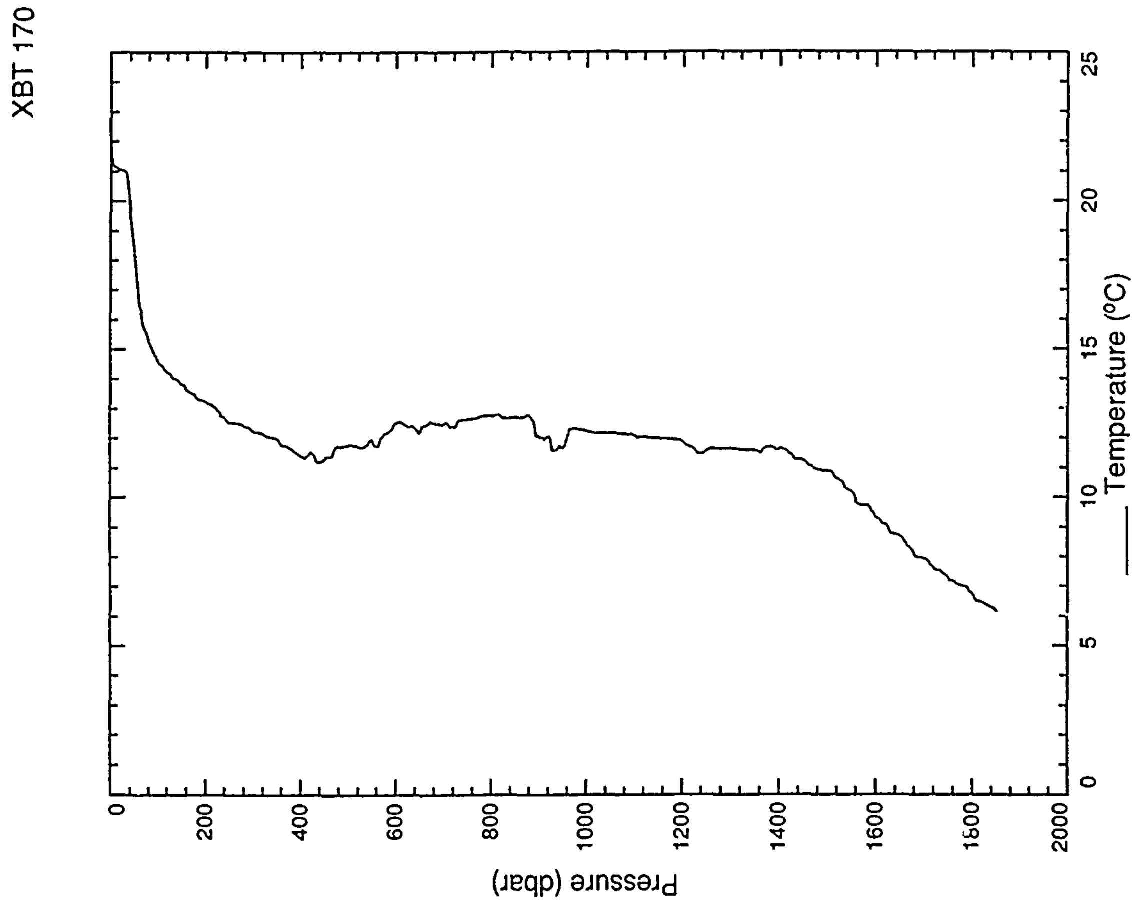
XBT 170
Pressure (dbar)
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200
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1400
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1800
2000
Temperature (ºC)
0
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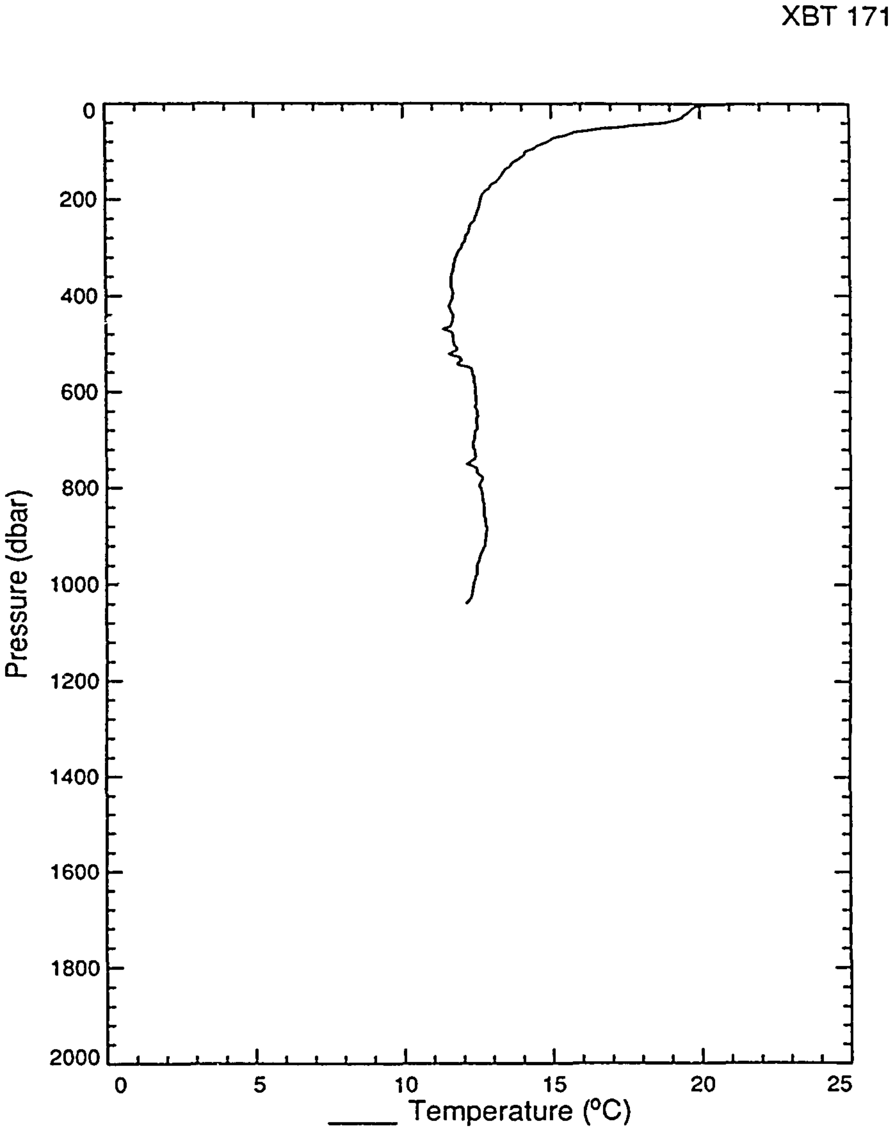
XBT 171
Pressure (dbar)
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200
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0
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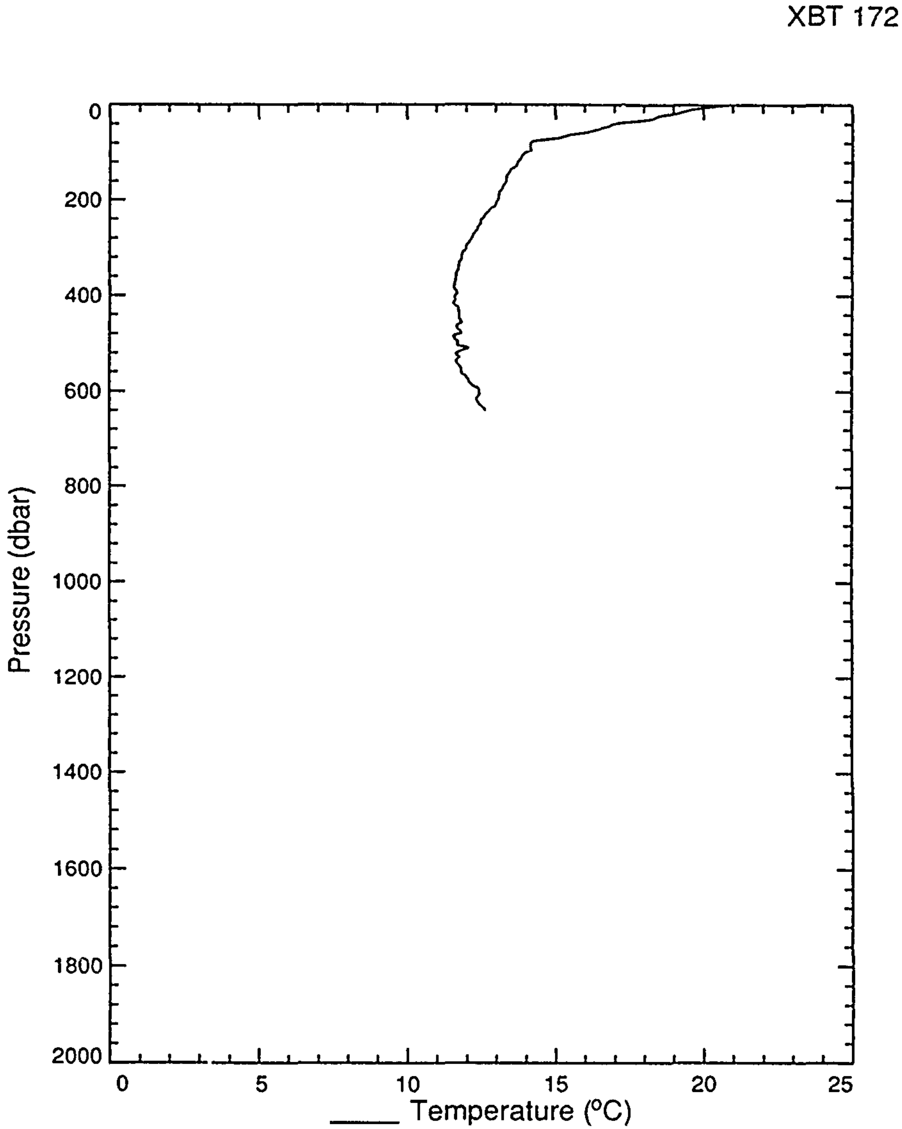
20
25
Temperature (°C)


XBT 172
Pressure (dbar)
0
200
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1200
1400
1600
1800
2000
0
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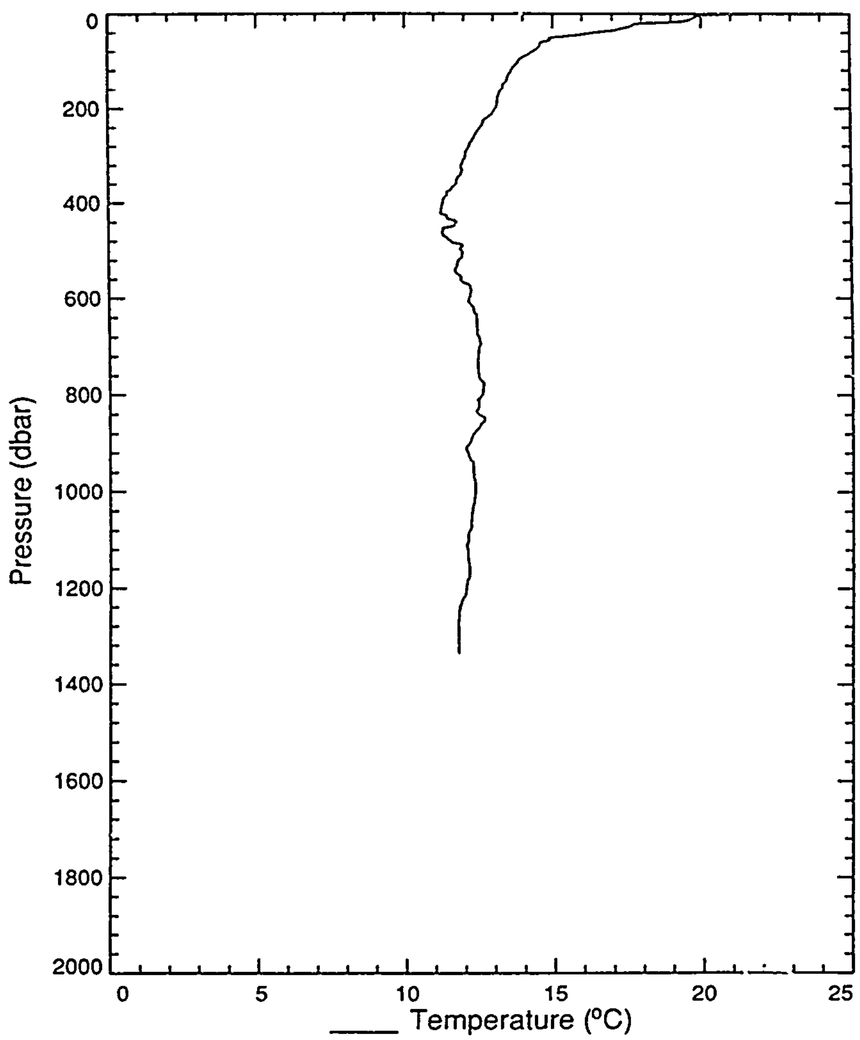
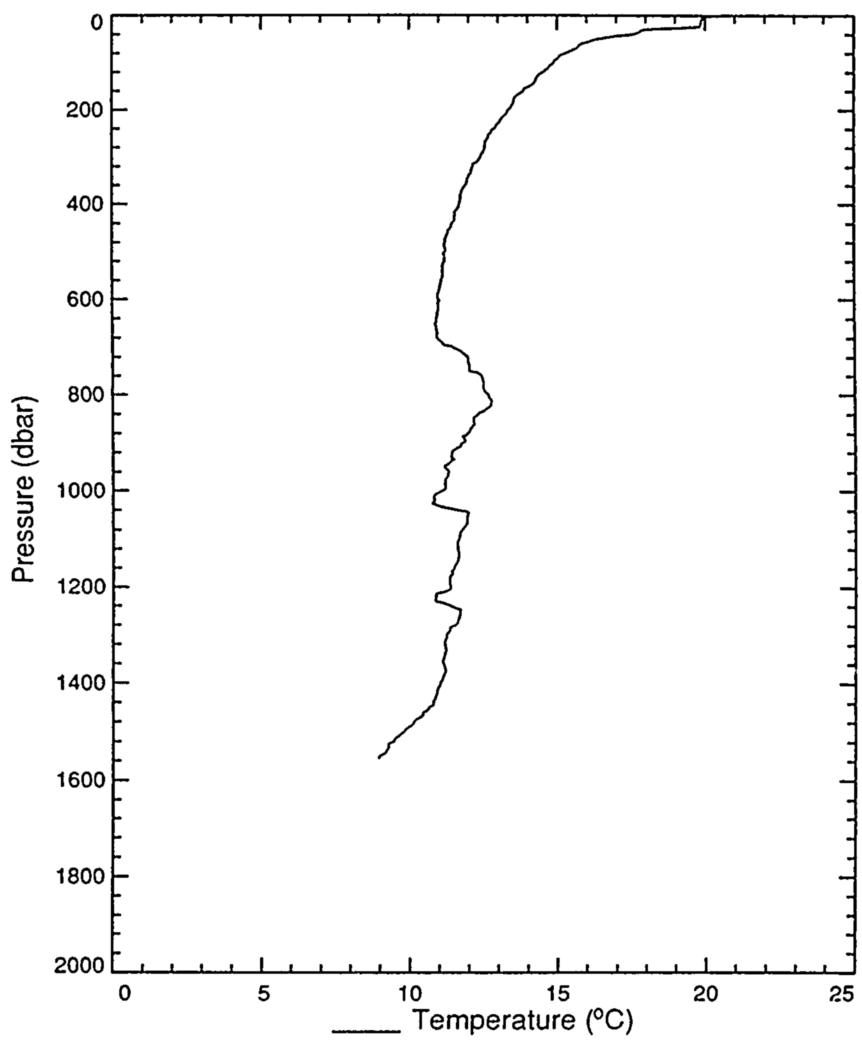
10
15
20
25
Temperature (°C)

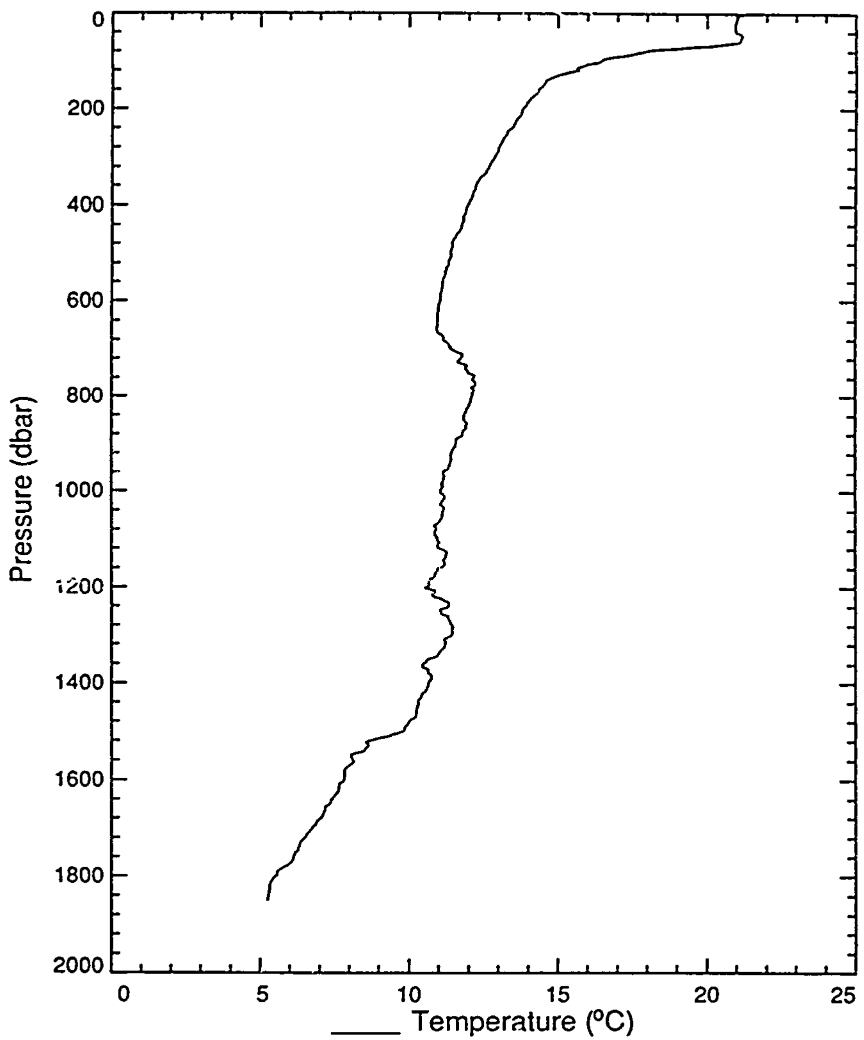
XBT 173



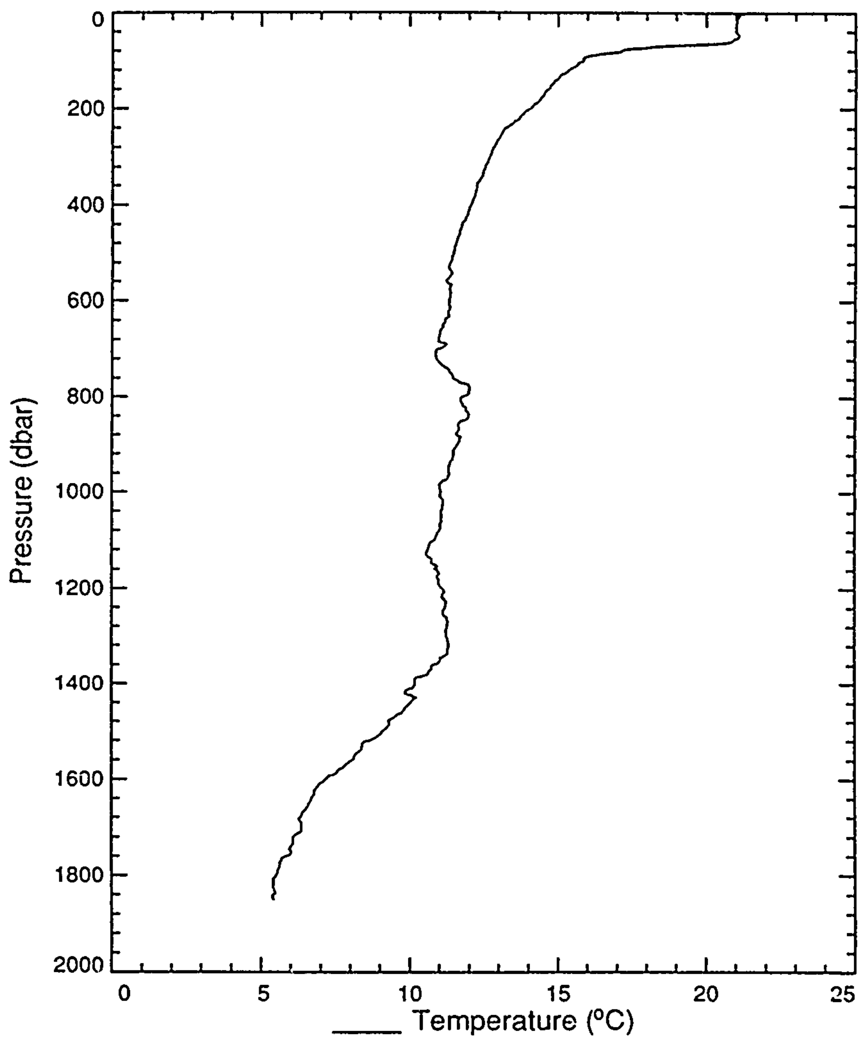
XBT 174

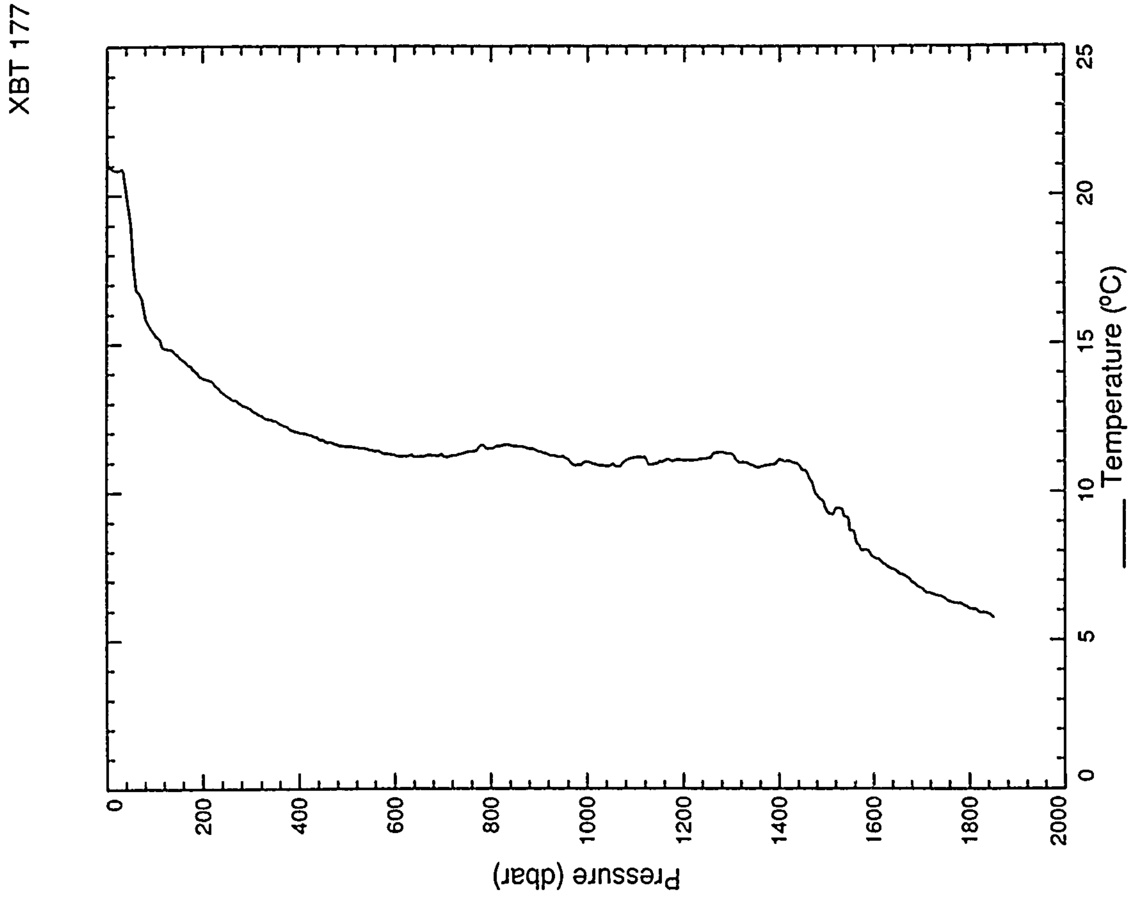


XBT 175



XBT 176




XBT 177
Pressure (dbar)
Temperature (ºC)
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200
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0
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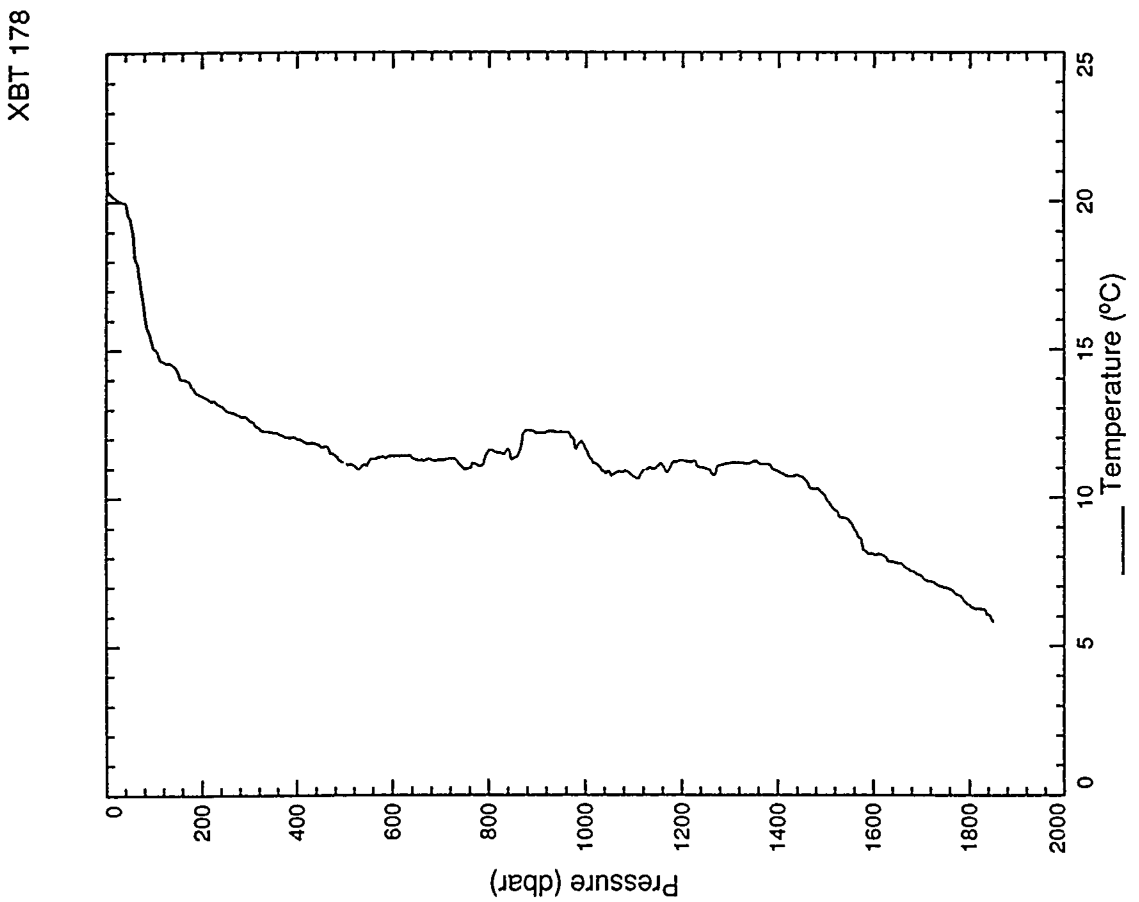
XBT 178
Pressure (dbar)
Temperature (ºC)
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200
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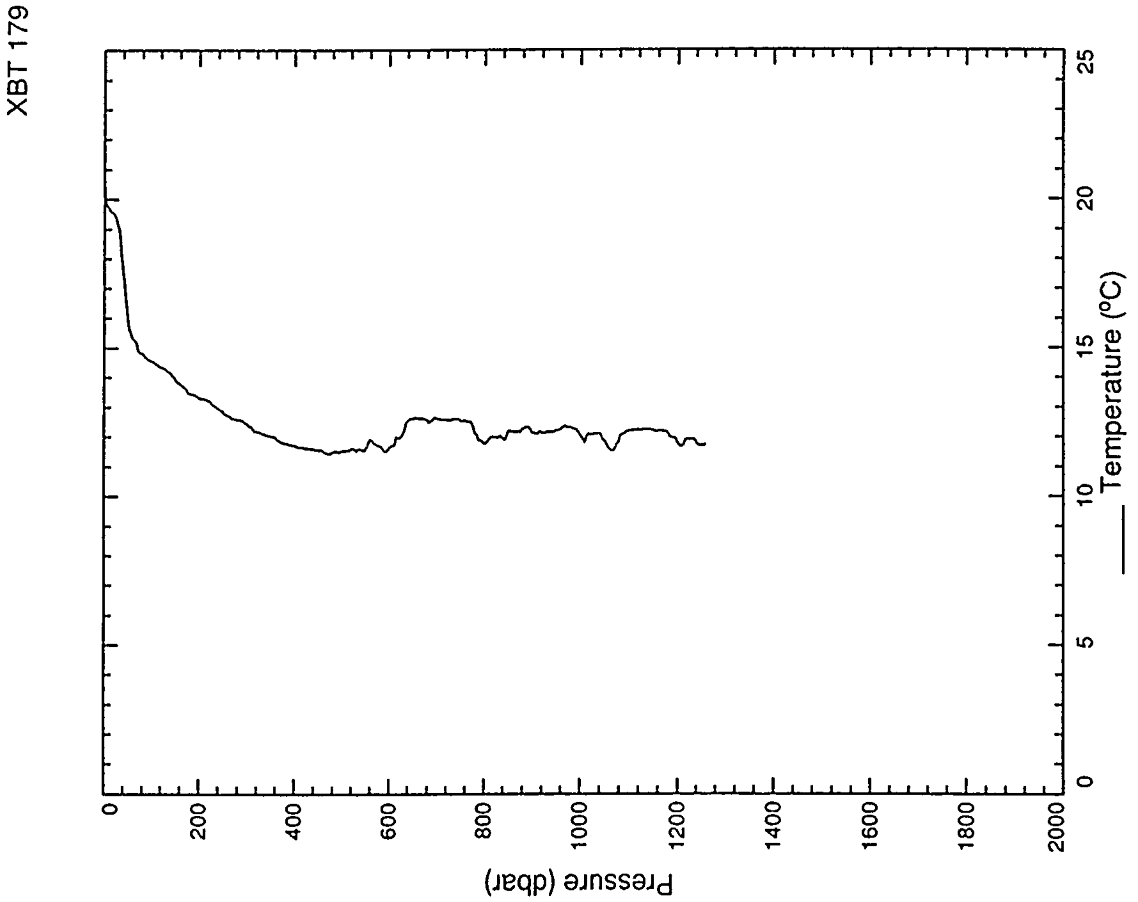
XBT 179
Pressure (dbar)
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2000
Temperature (°C)
0
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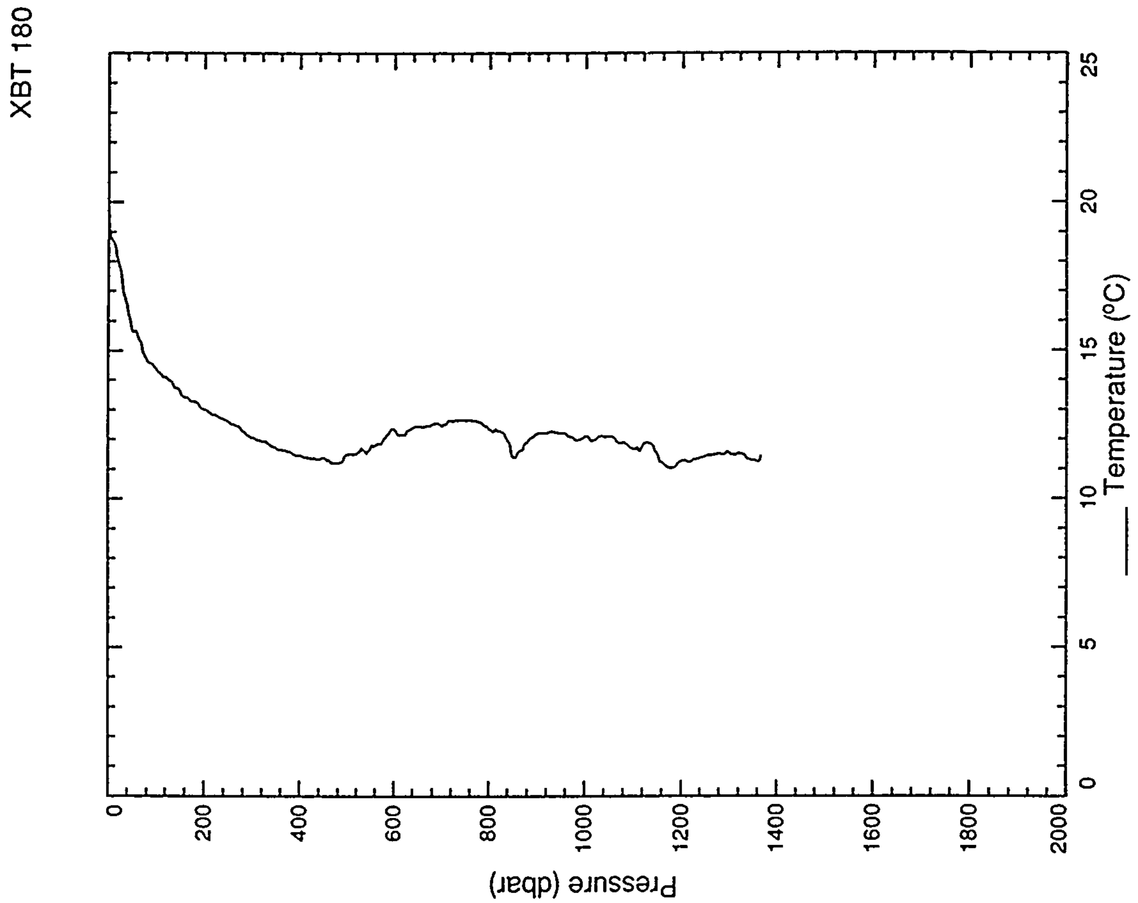
XBT 180
Pressure (dbar)
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1400
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2000
Temperature (°C)
0
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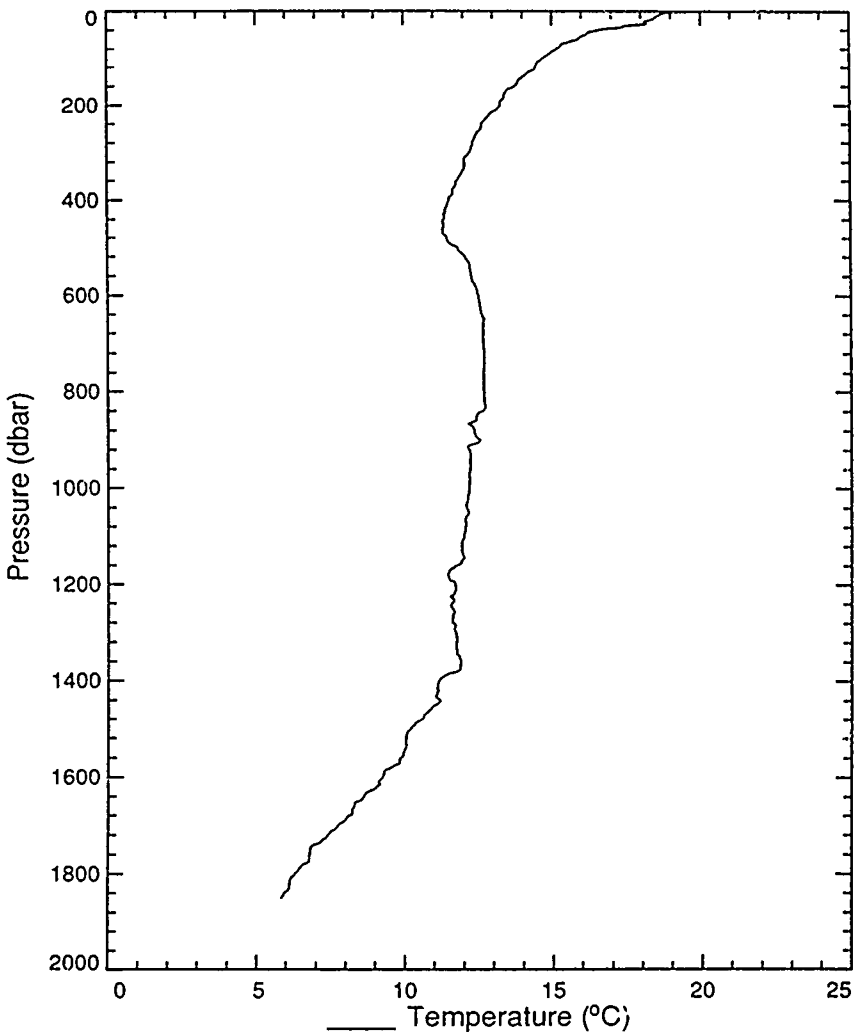
XBT 181



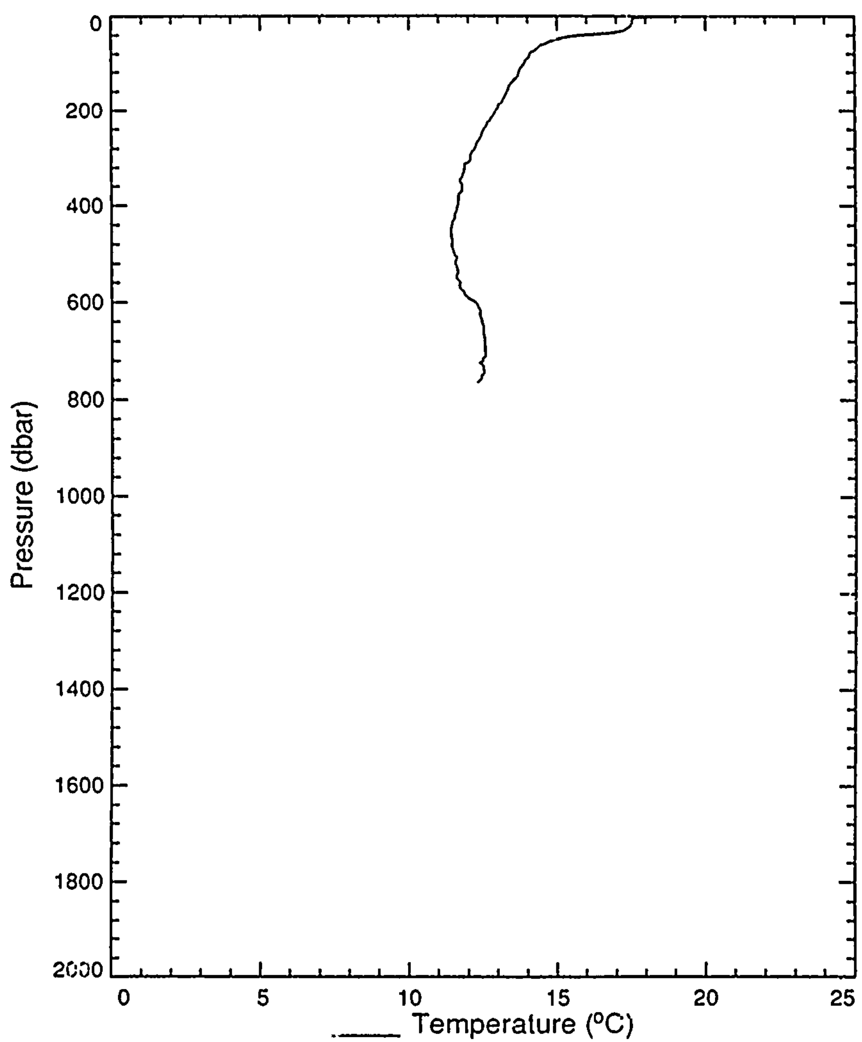
XBT 182

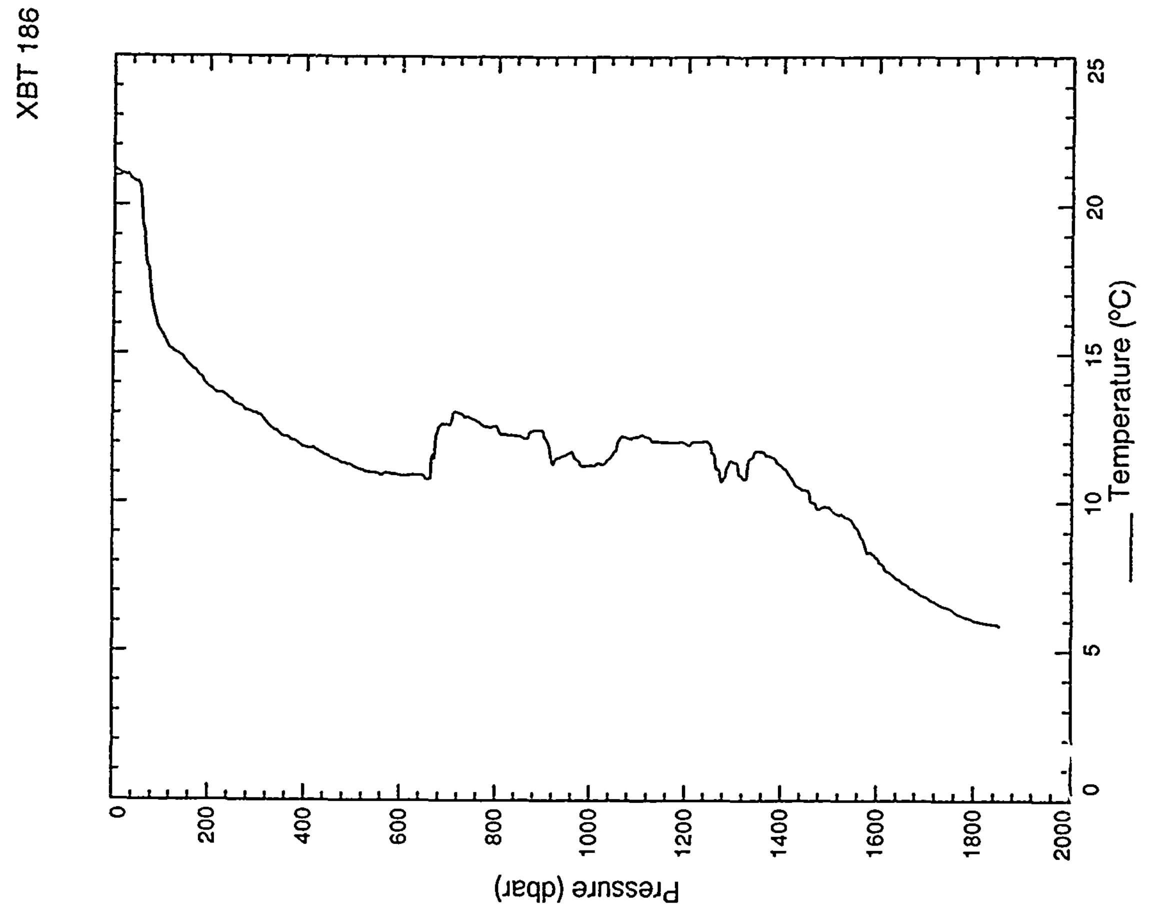
Bad Data

XBT 183

Bad Data

XBT 184




XBT 186
Pressure (dbar)
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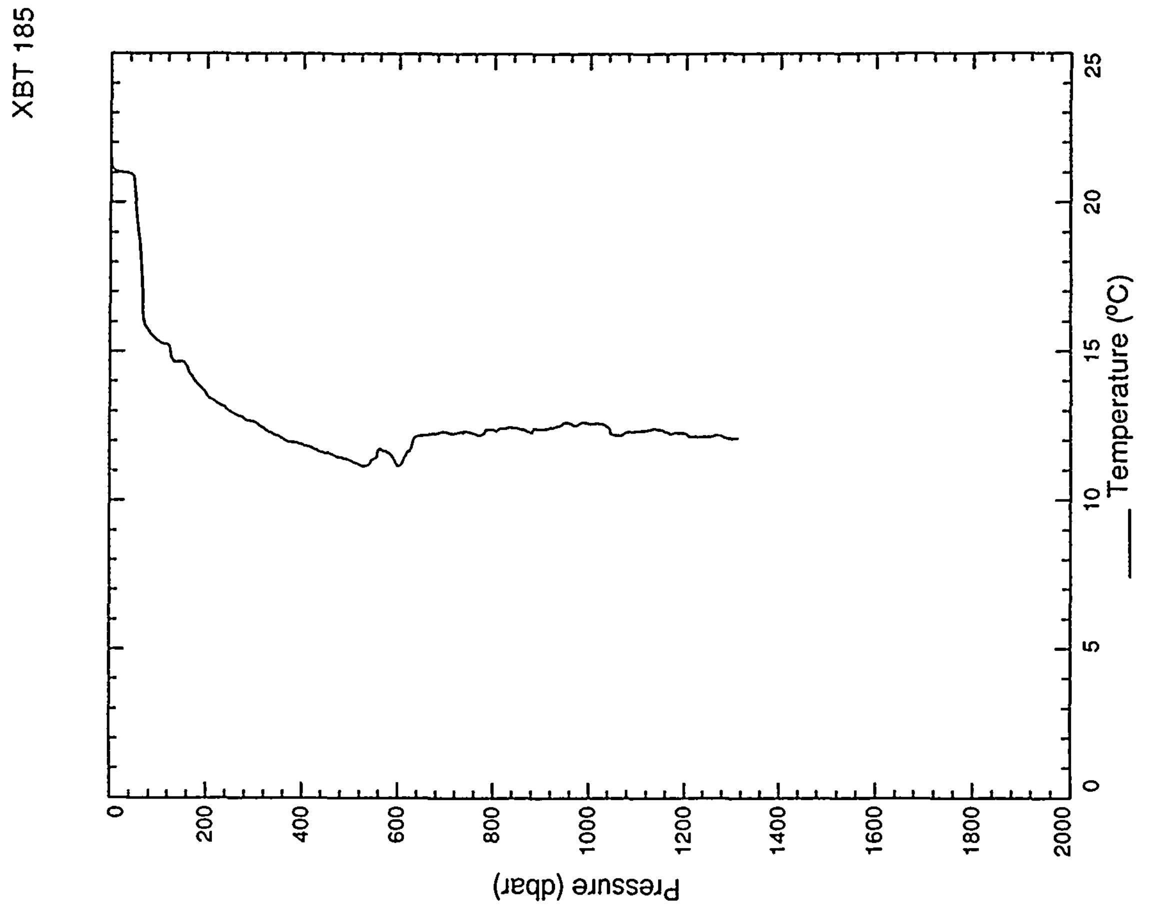
20
25
Temperature (°C)


XBT 185
Pressure (dbar)
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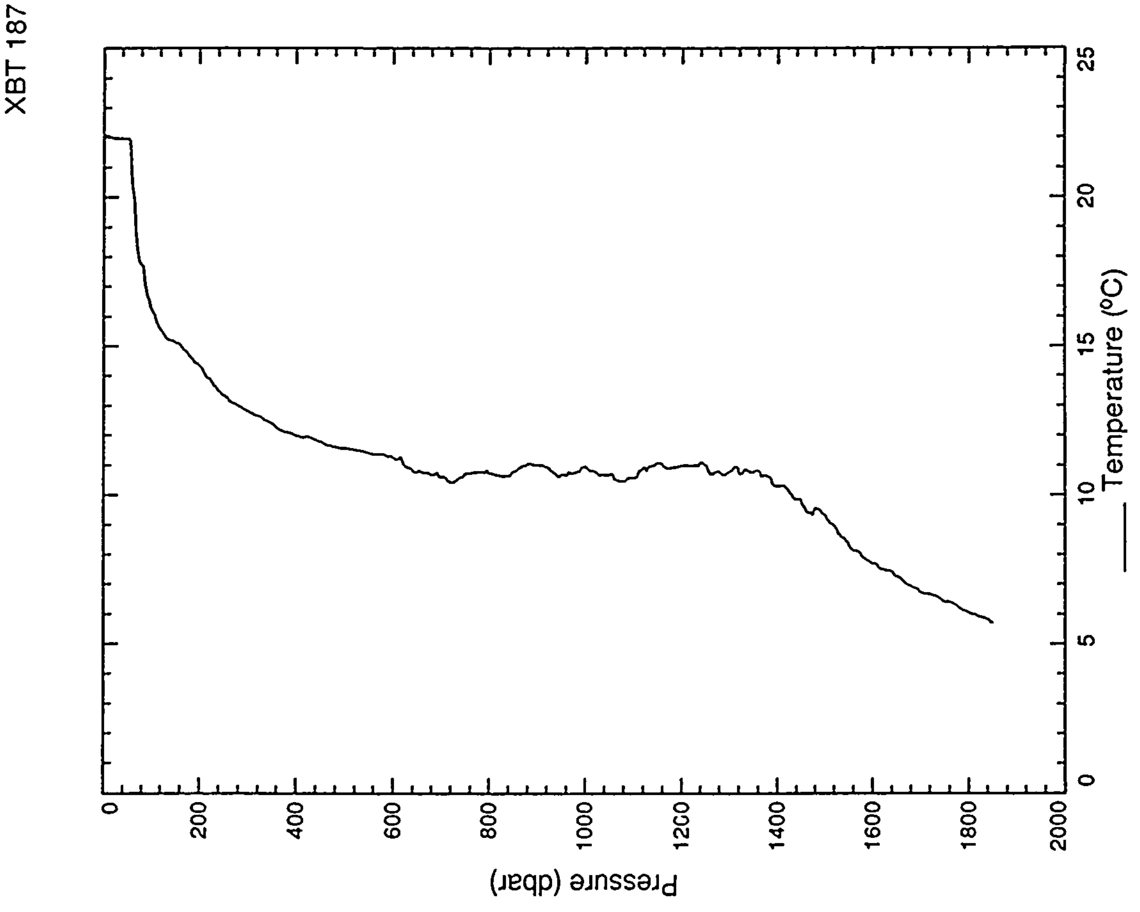
25
Temperature (°C)


XBT 187
Pressure (dbar)
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Temperature (ºC)
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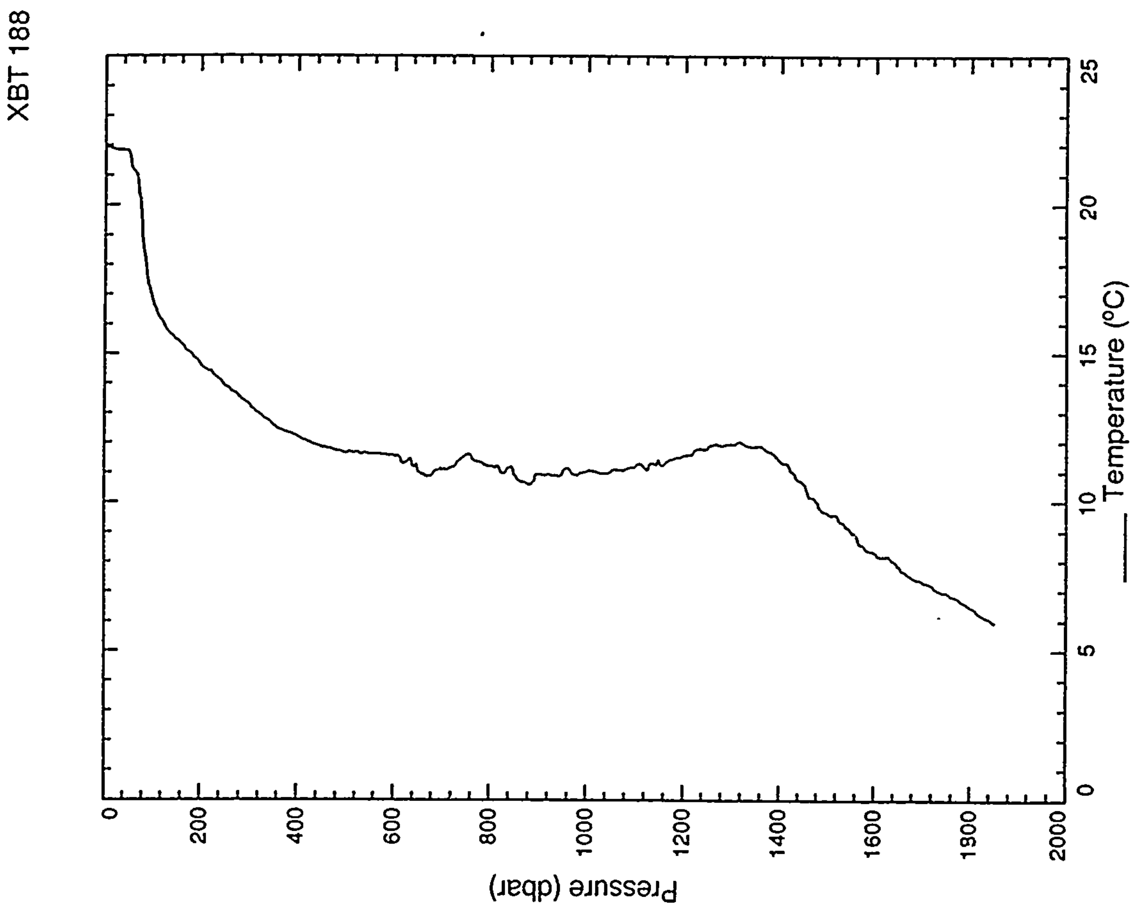
XBT 188
Pressure (dbar)
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Temperature (ºC)
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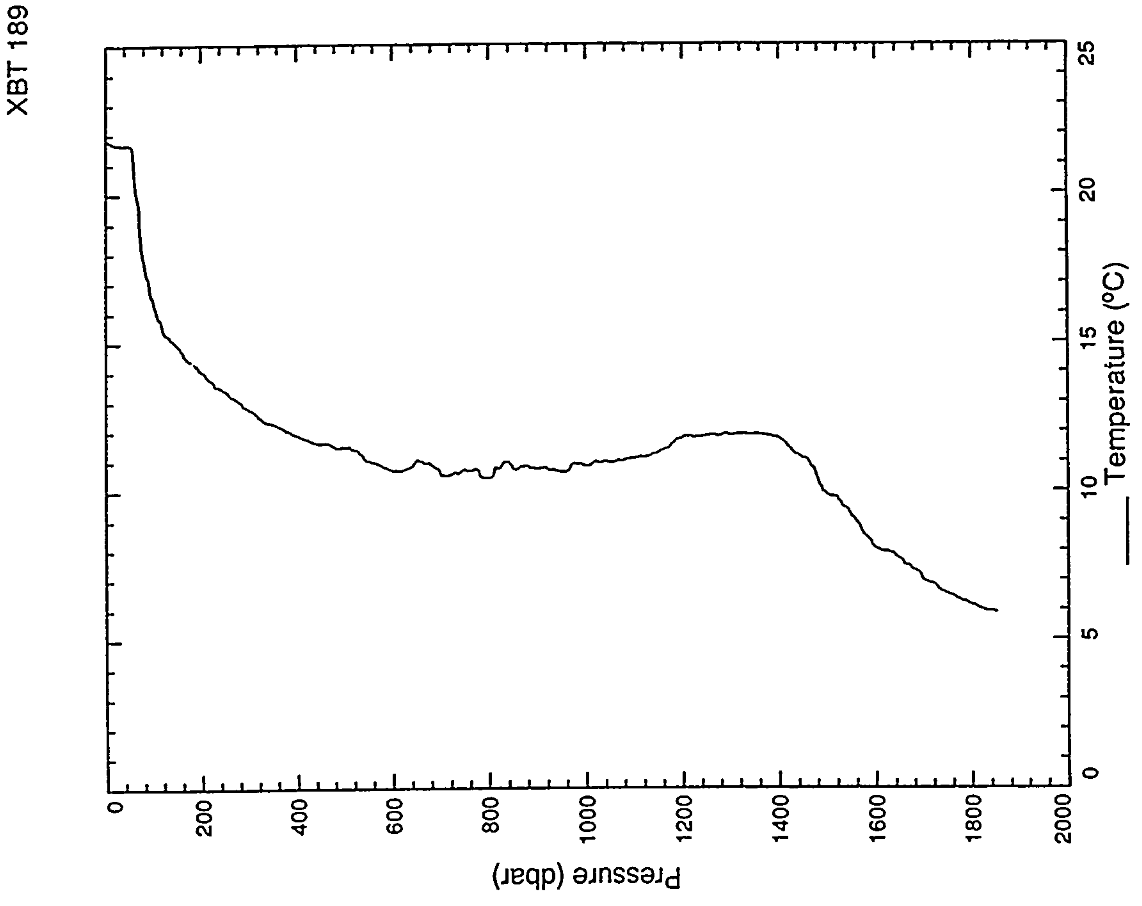

XBT 189
Pressure (dbar)
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Temperature (ºC)
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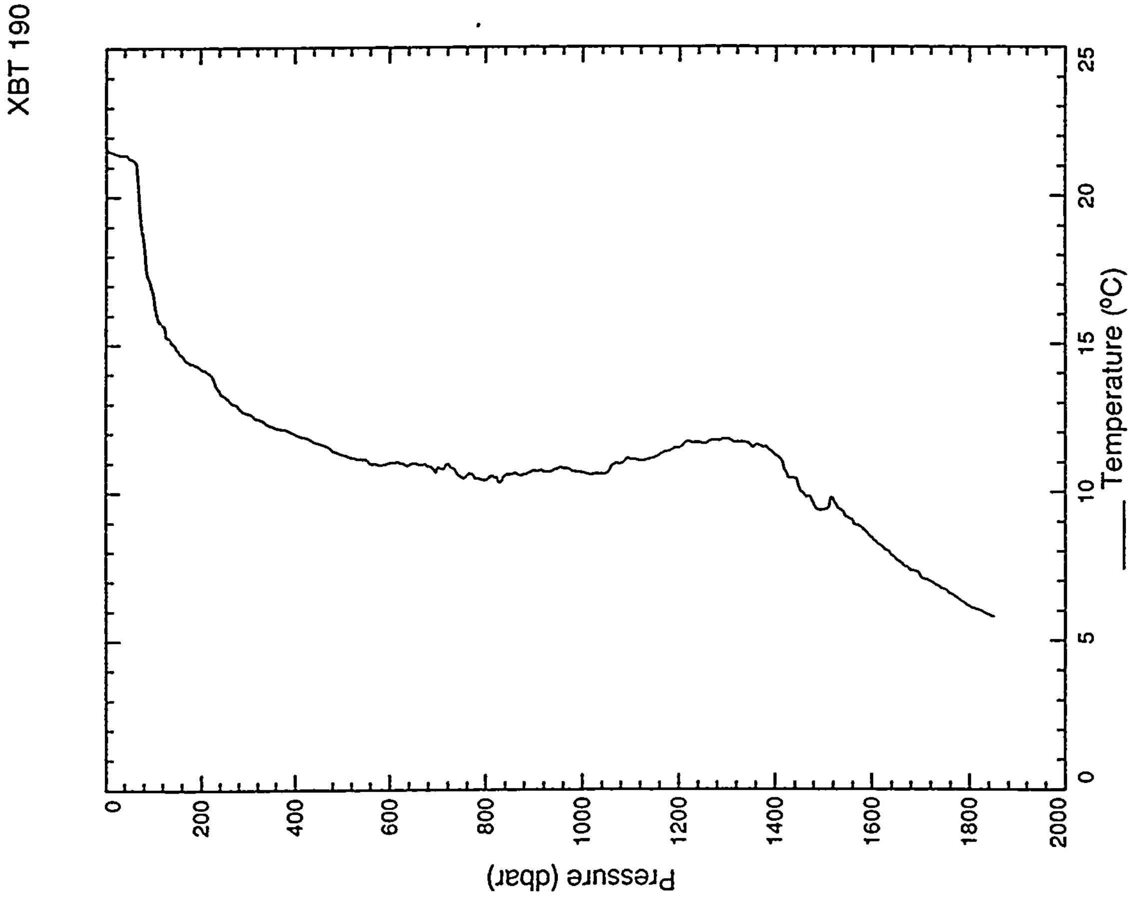

XBT 190
Pressure (dbar)
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2000
Temperature (ºC)
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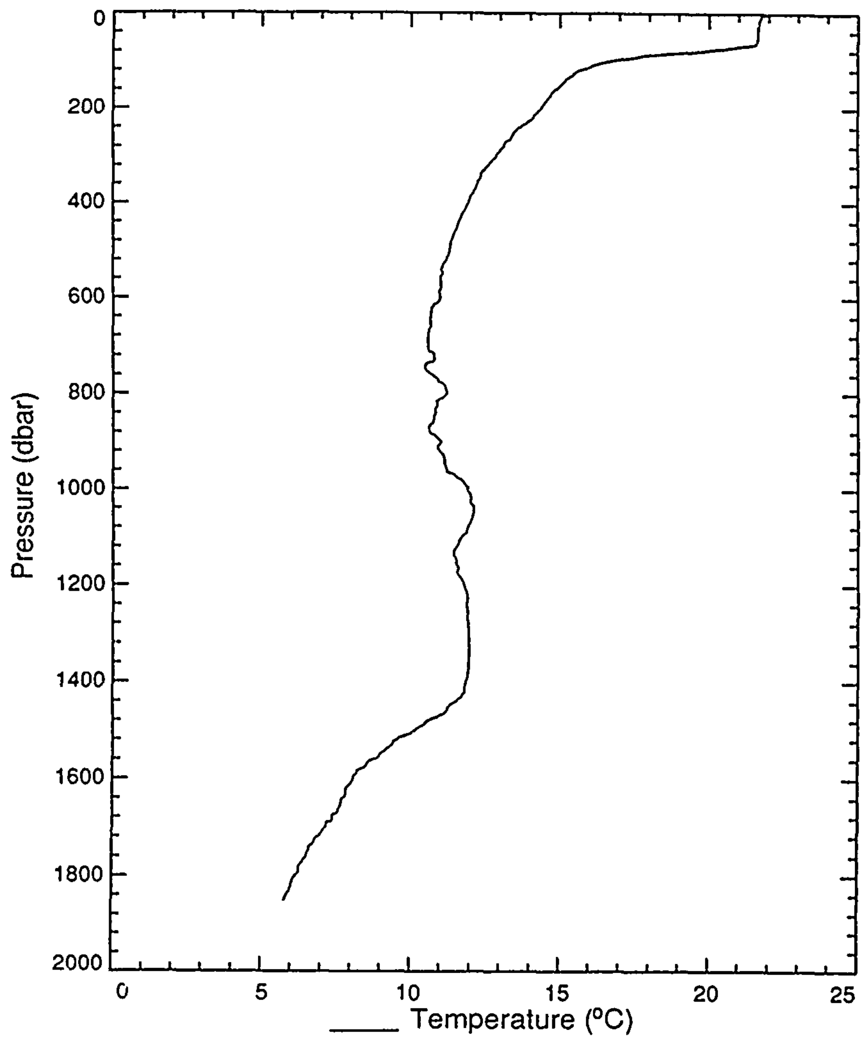
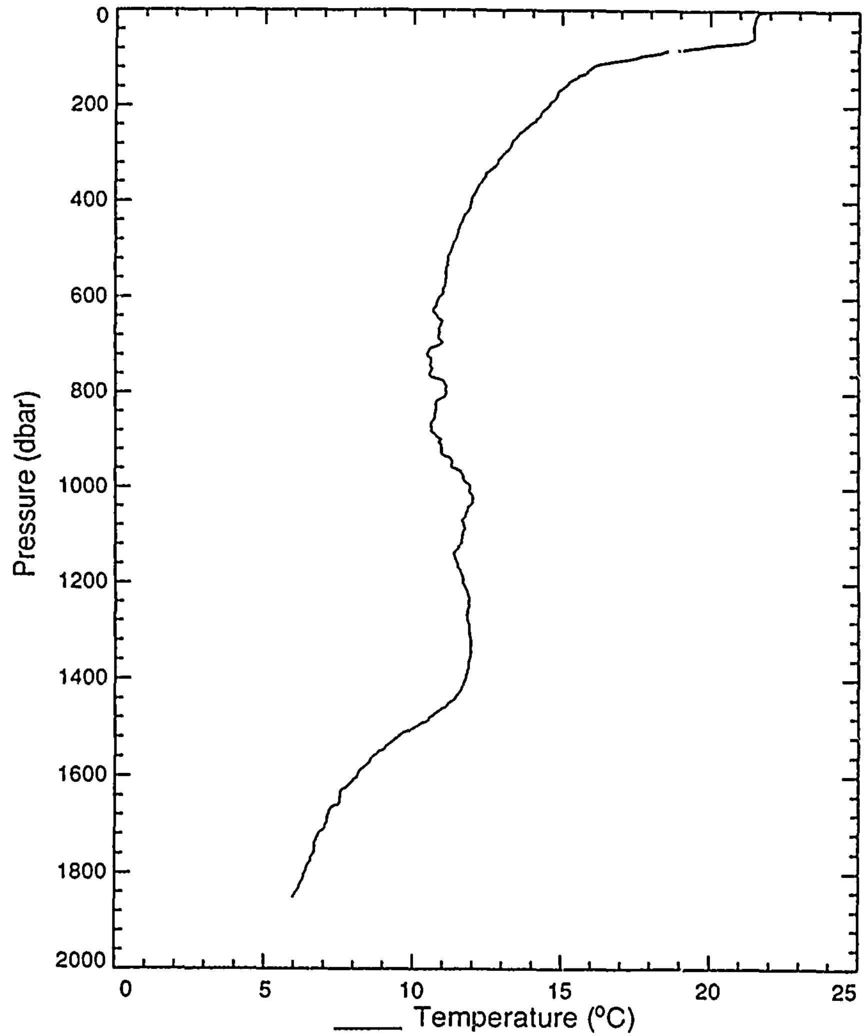
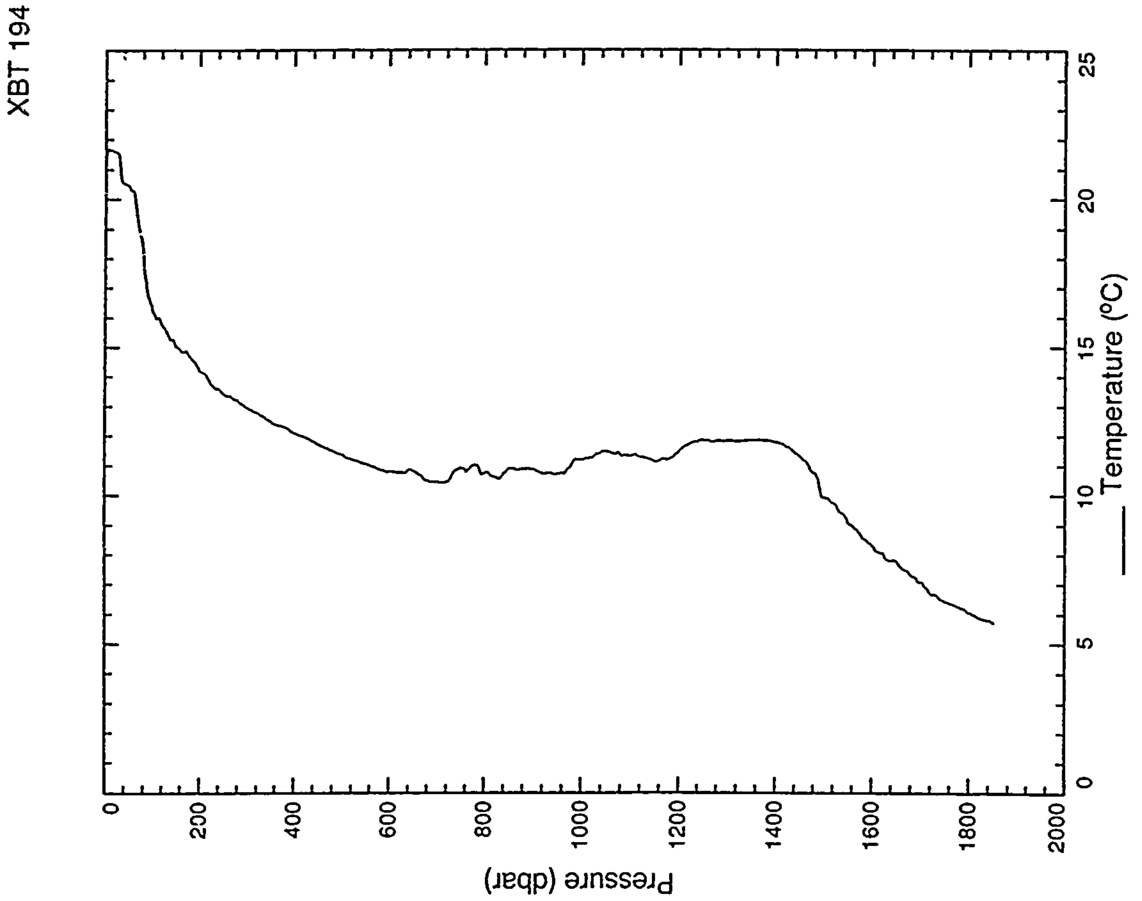
XBT 191



XBT 192




XBT 194
Pressure (dbar)
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1600
1800
2000
Temperature (°C)
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15
20
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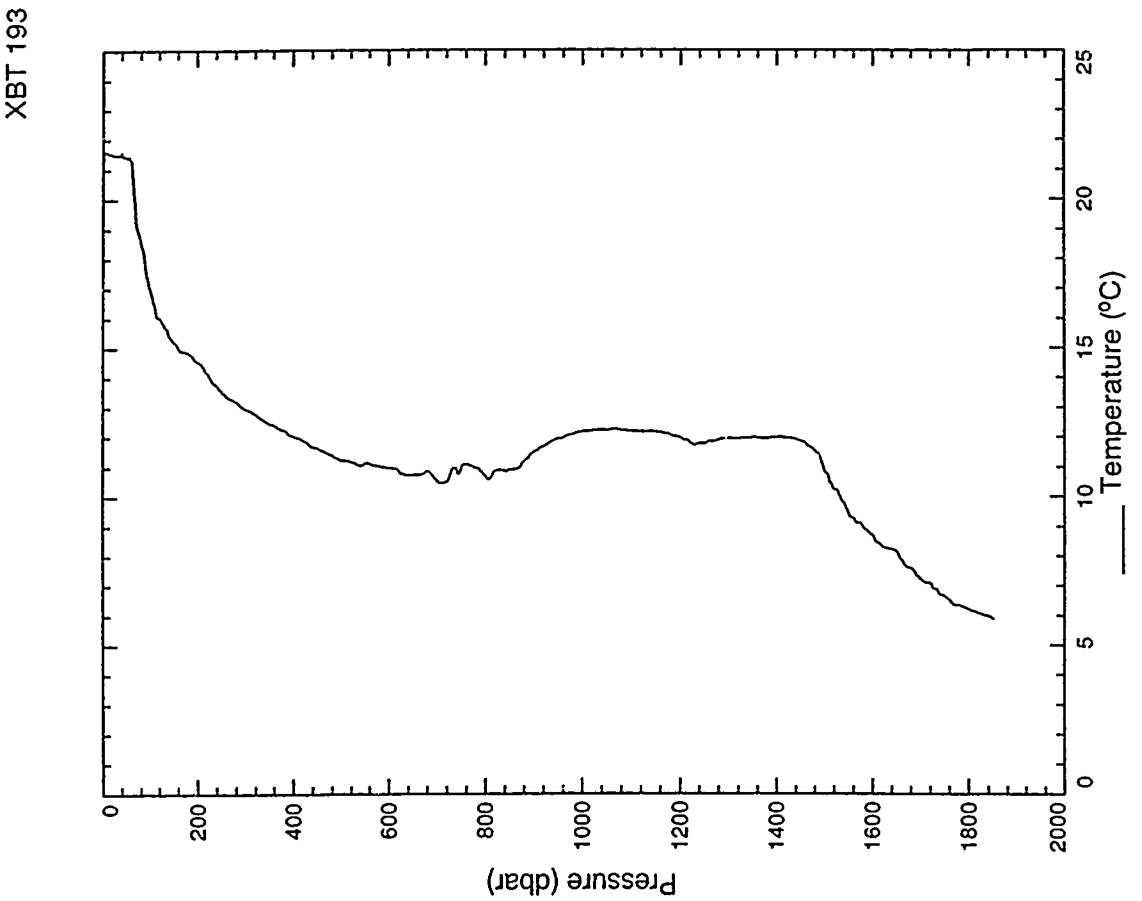
XBT 193
Pressure (dbar)
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1400
1600
1800
2000
Temperature (°C)
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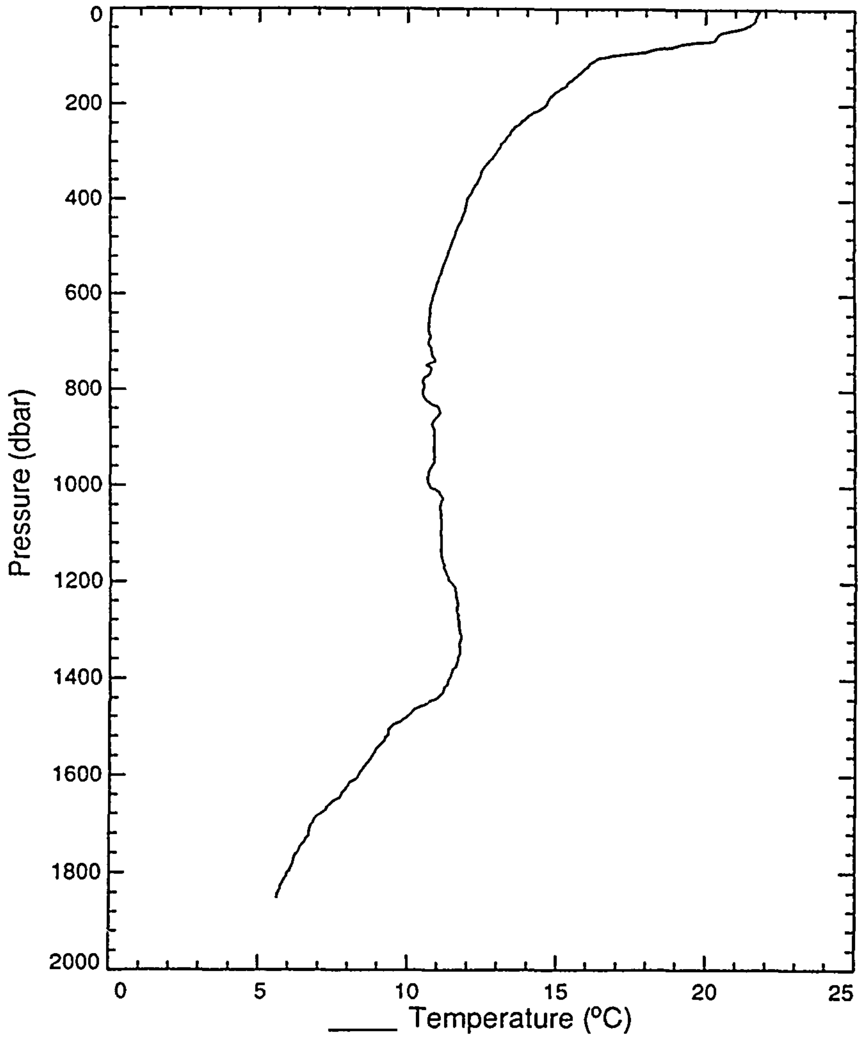
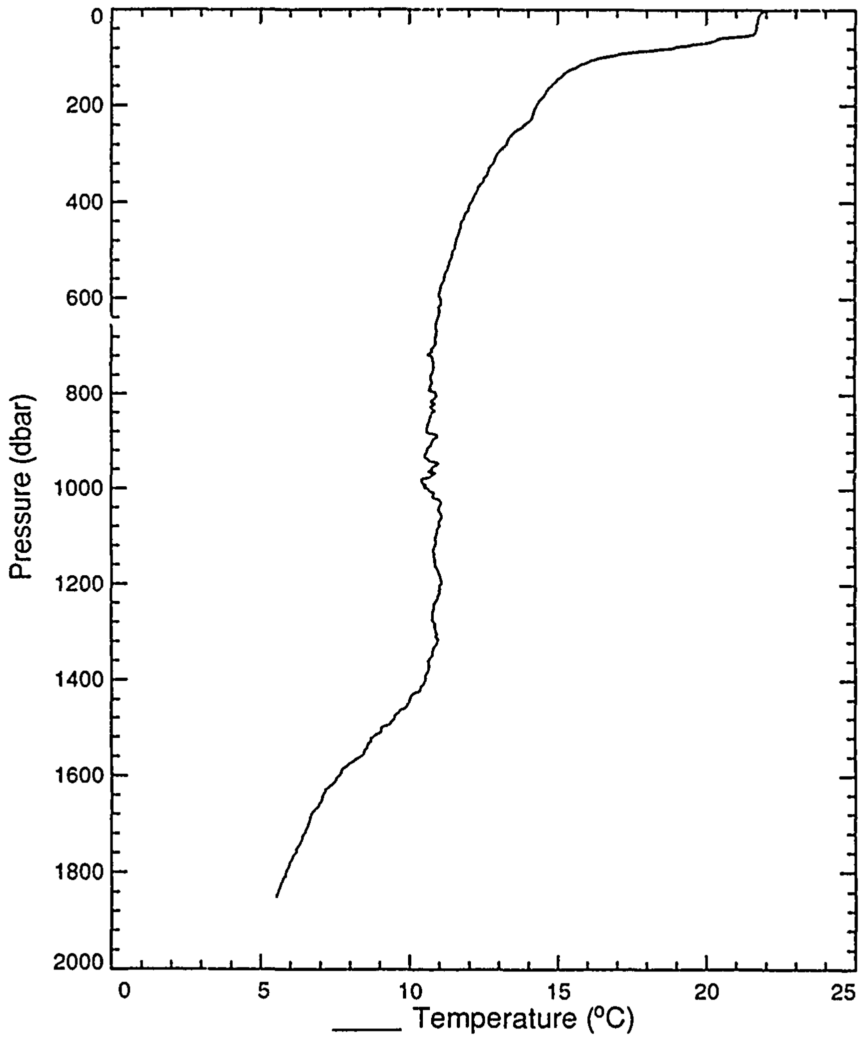
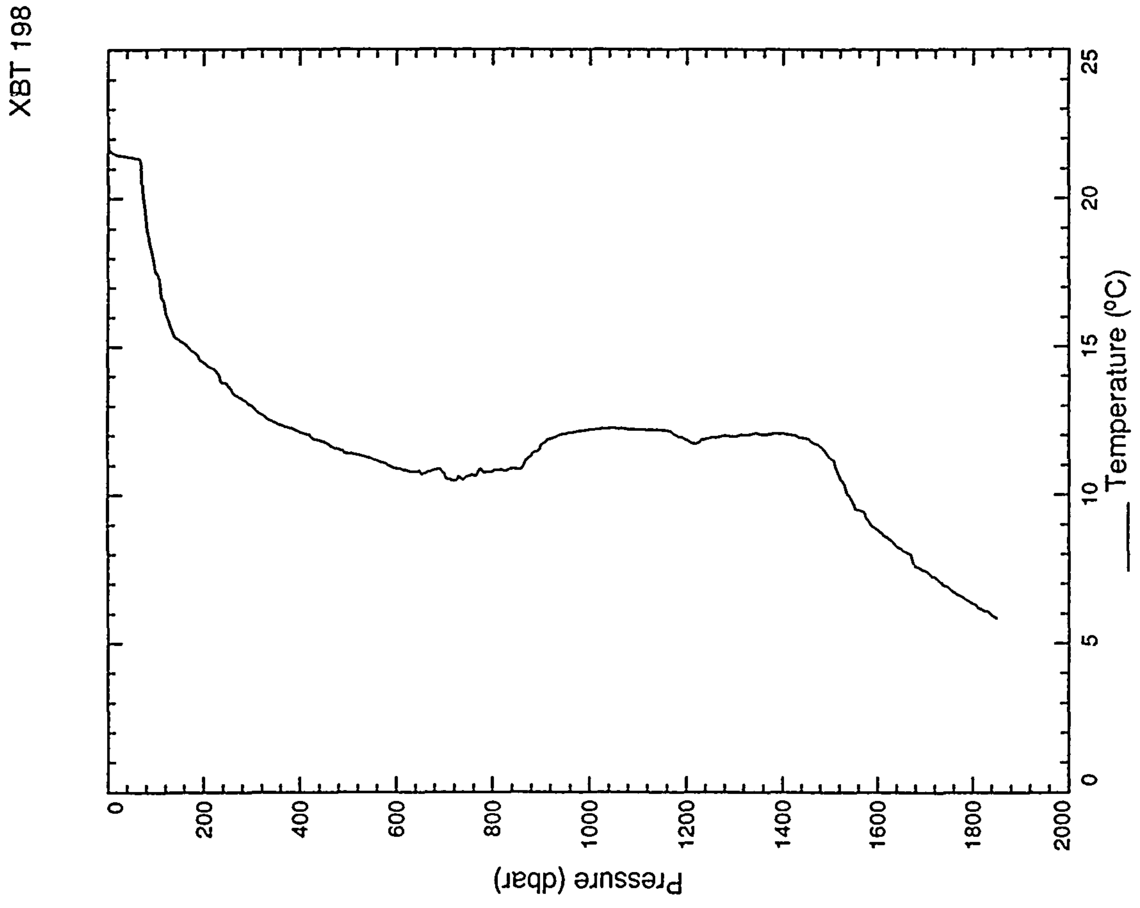
20
25

XBT 195



XBT 196




XBT 198
Pressure (dbar)
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1200
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1600
1800
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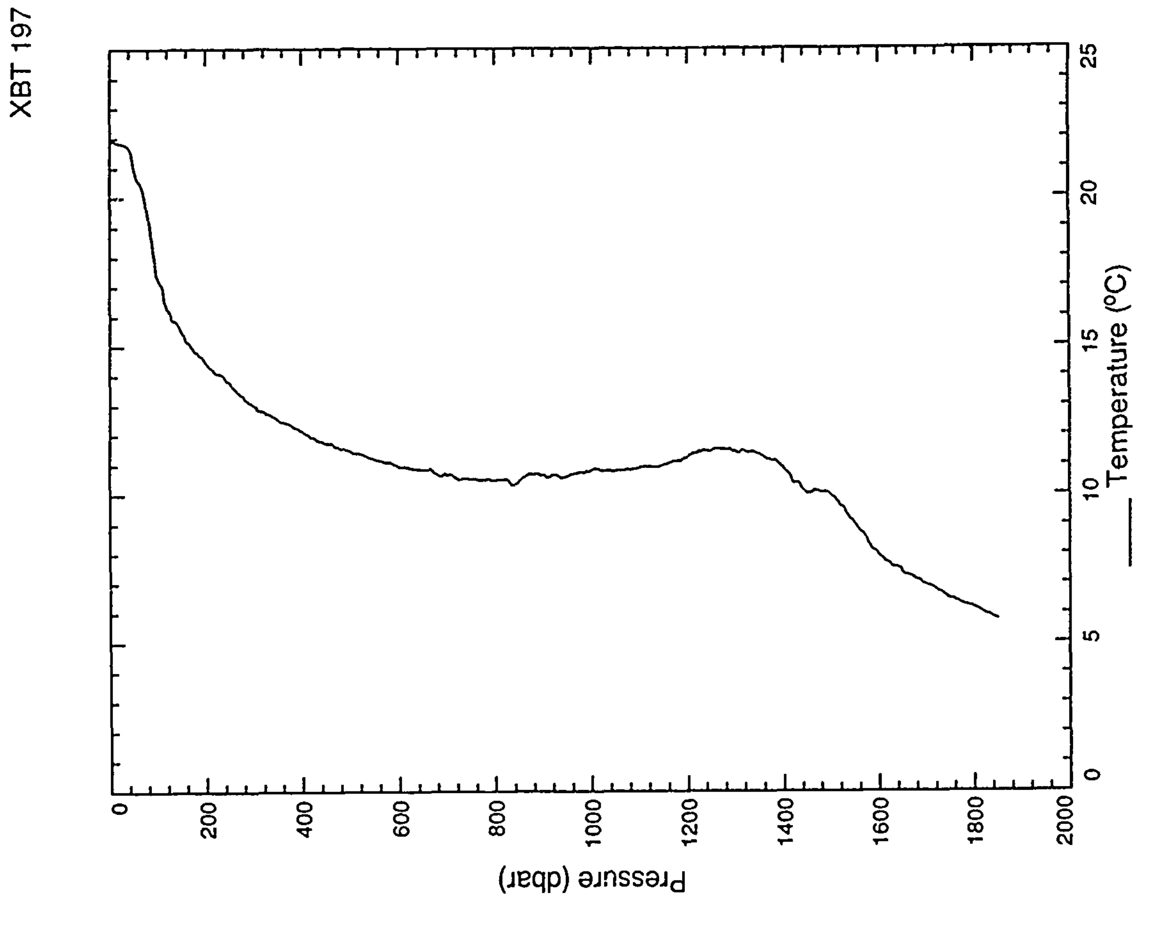
0
5
10
15
20
25
Temperature (ºC)


XBT 197
Pressure (dbar)
0
200
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1200
1400
1600
1800
2000
0
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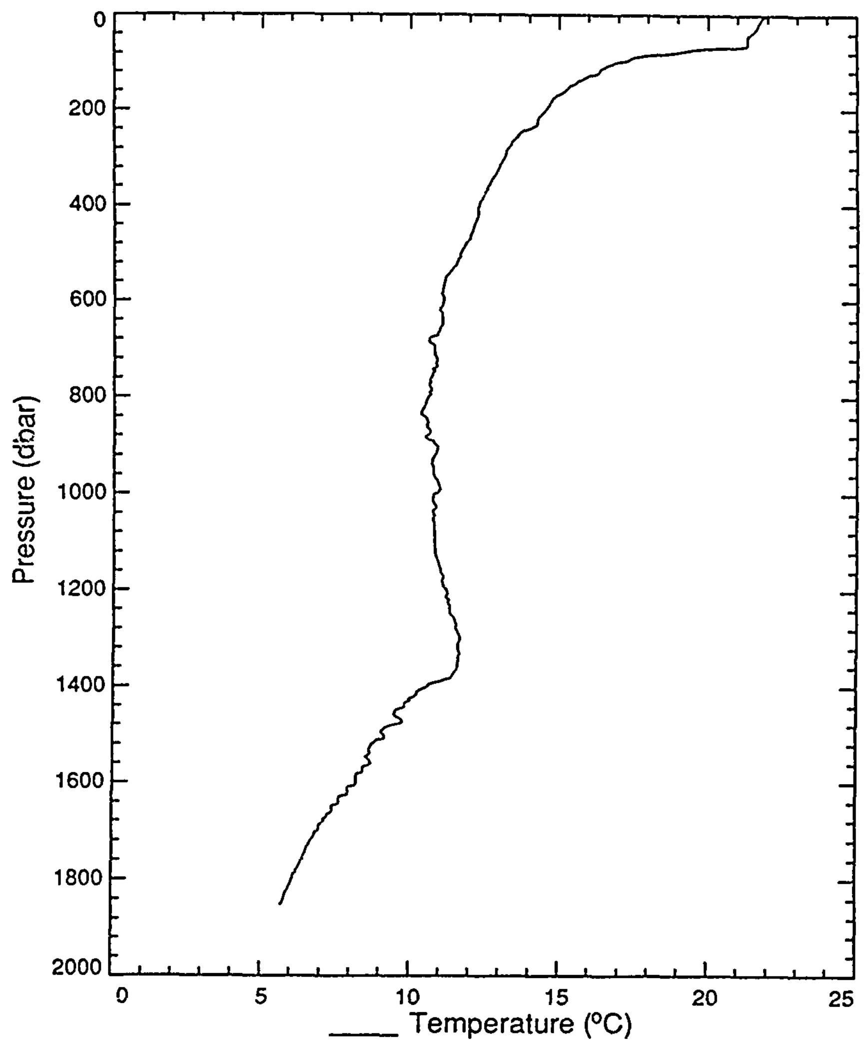
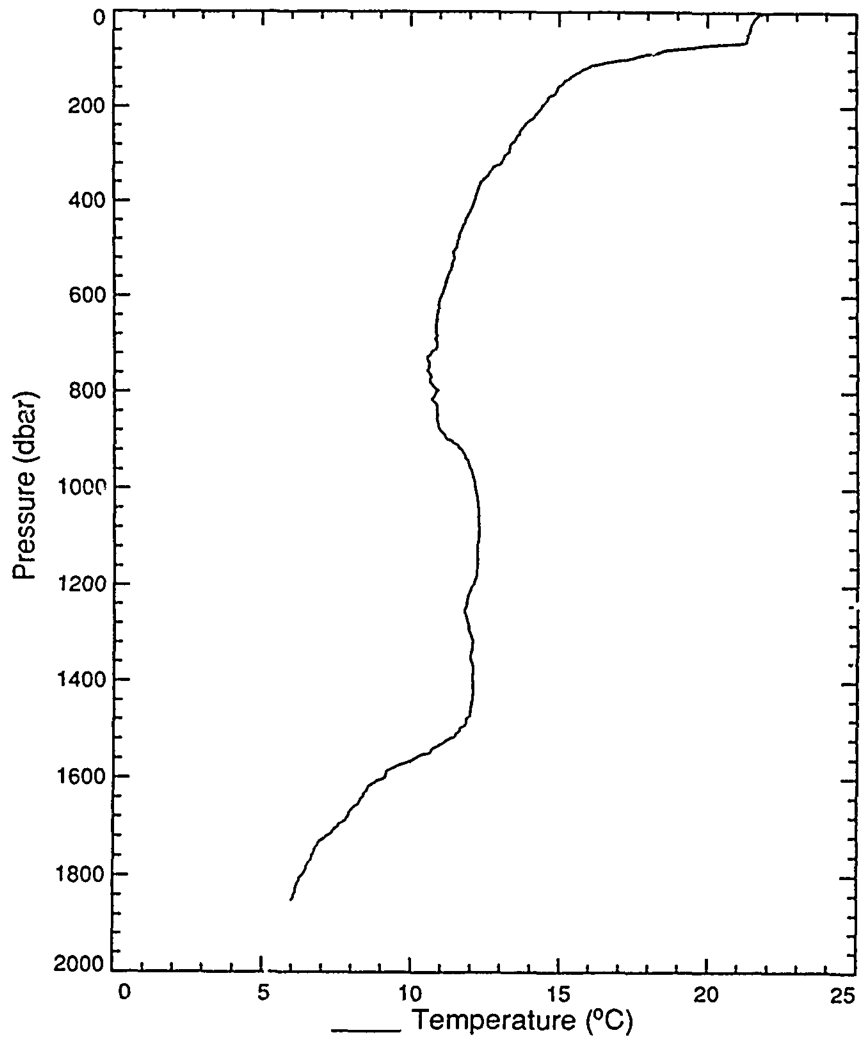
10
15
20
25
Temperature (ºC)

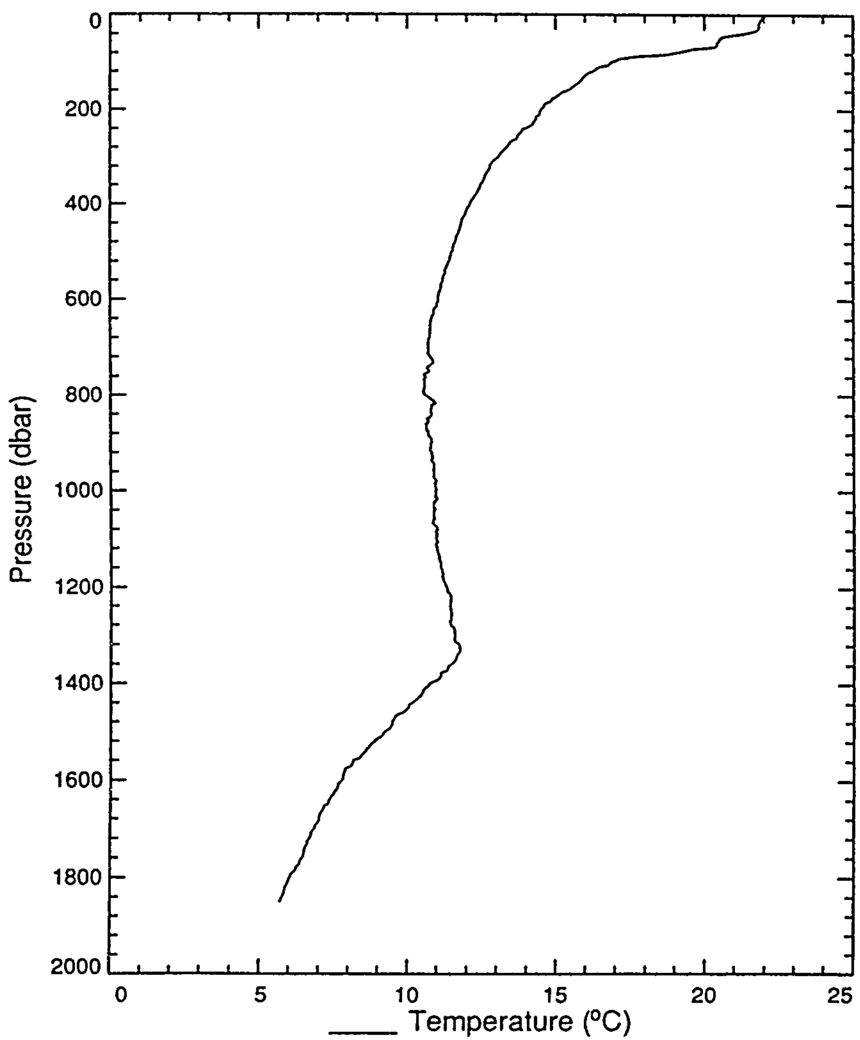
XBT 199



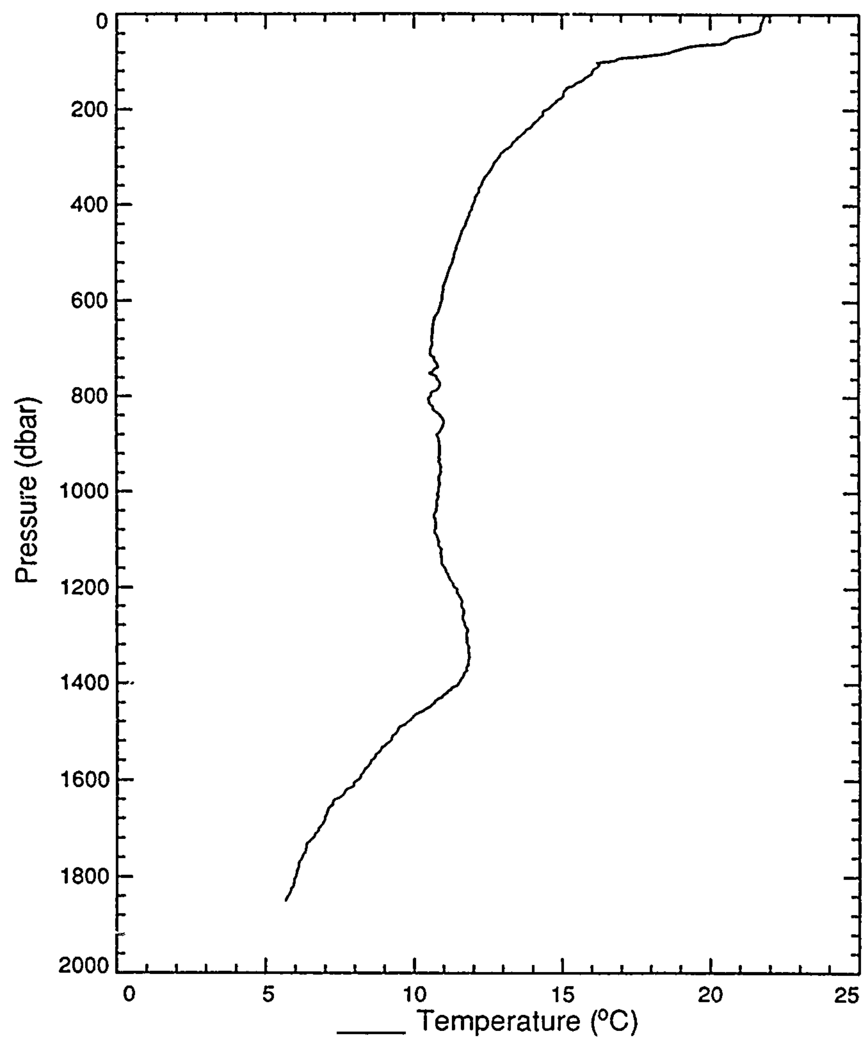
XBT 200



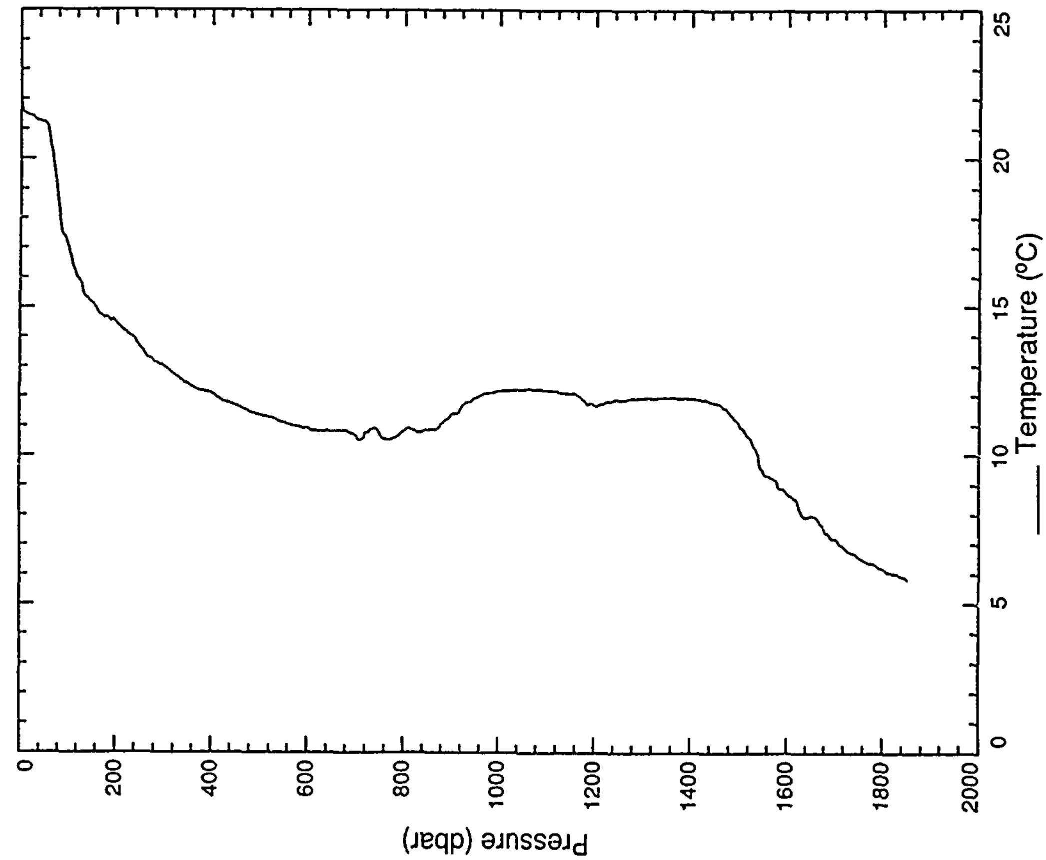
XBT 201



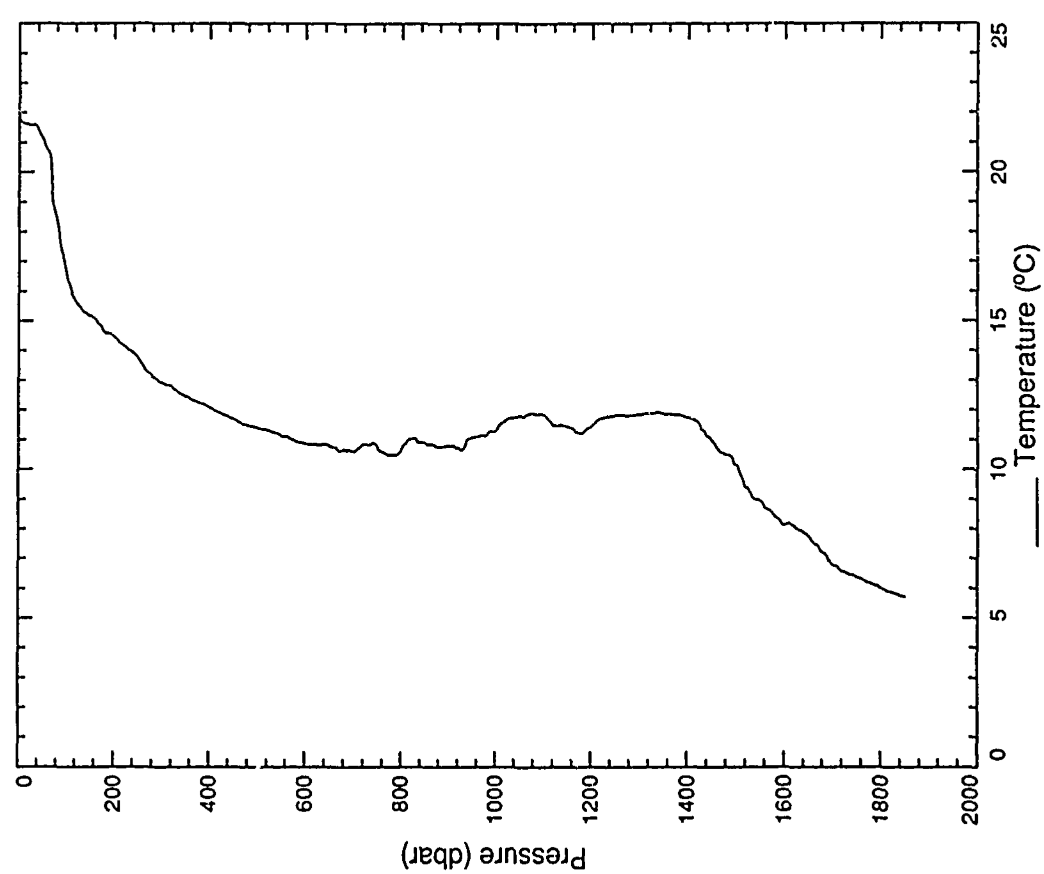
XBT 202



XBT 204



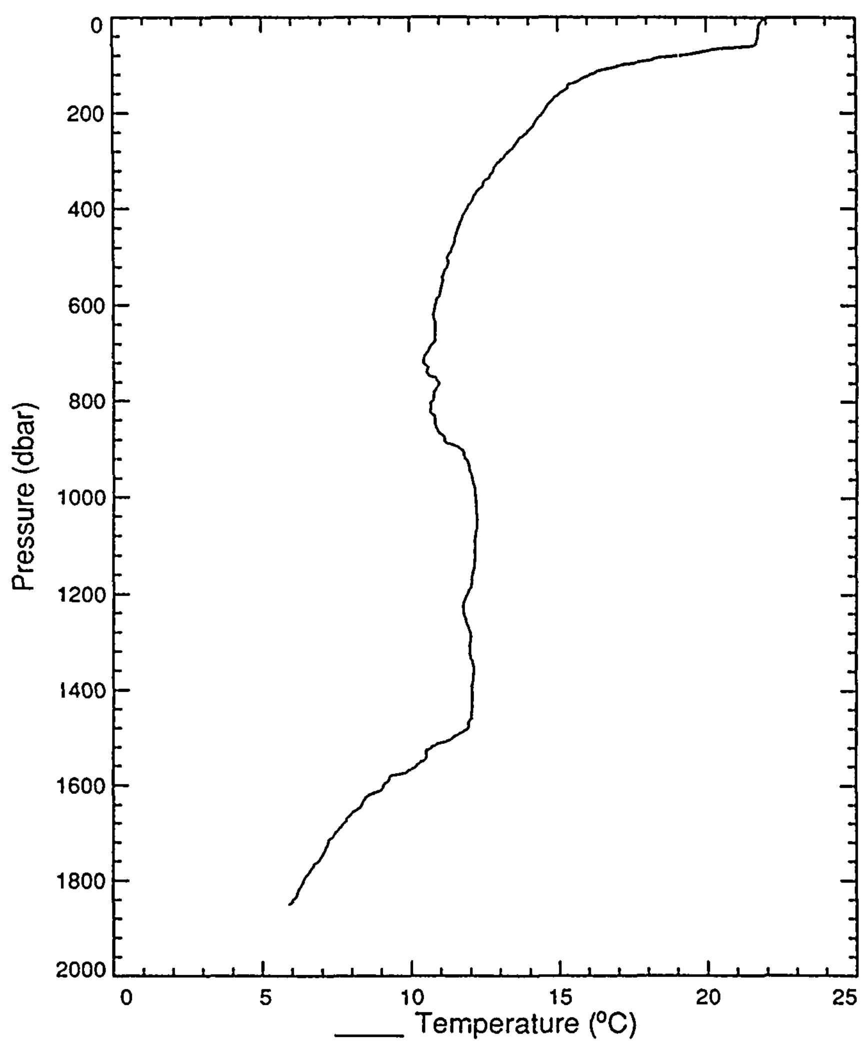
XBT 203

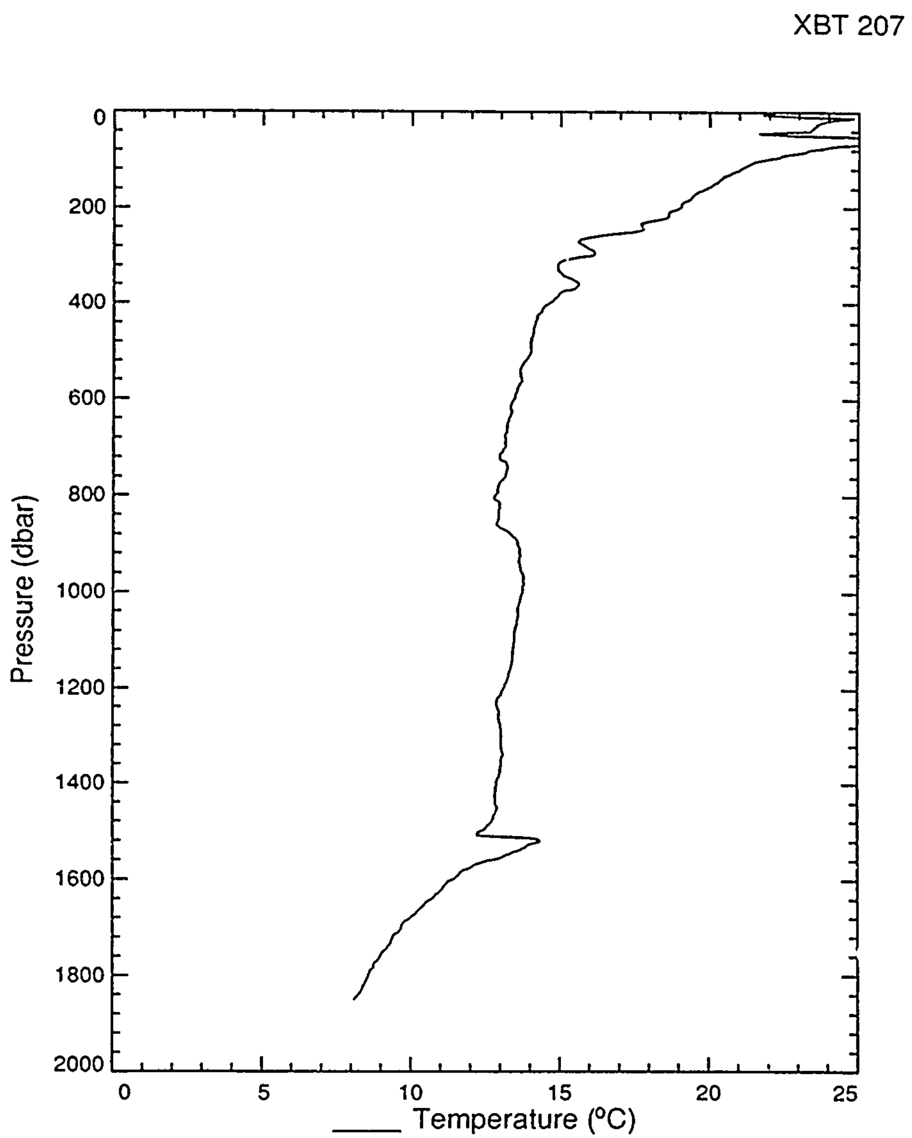


XBT 205

Bad Data

XBT 206




XBT 207
Pressure (dbar)
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1400
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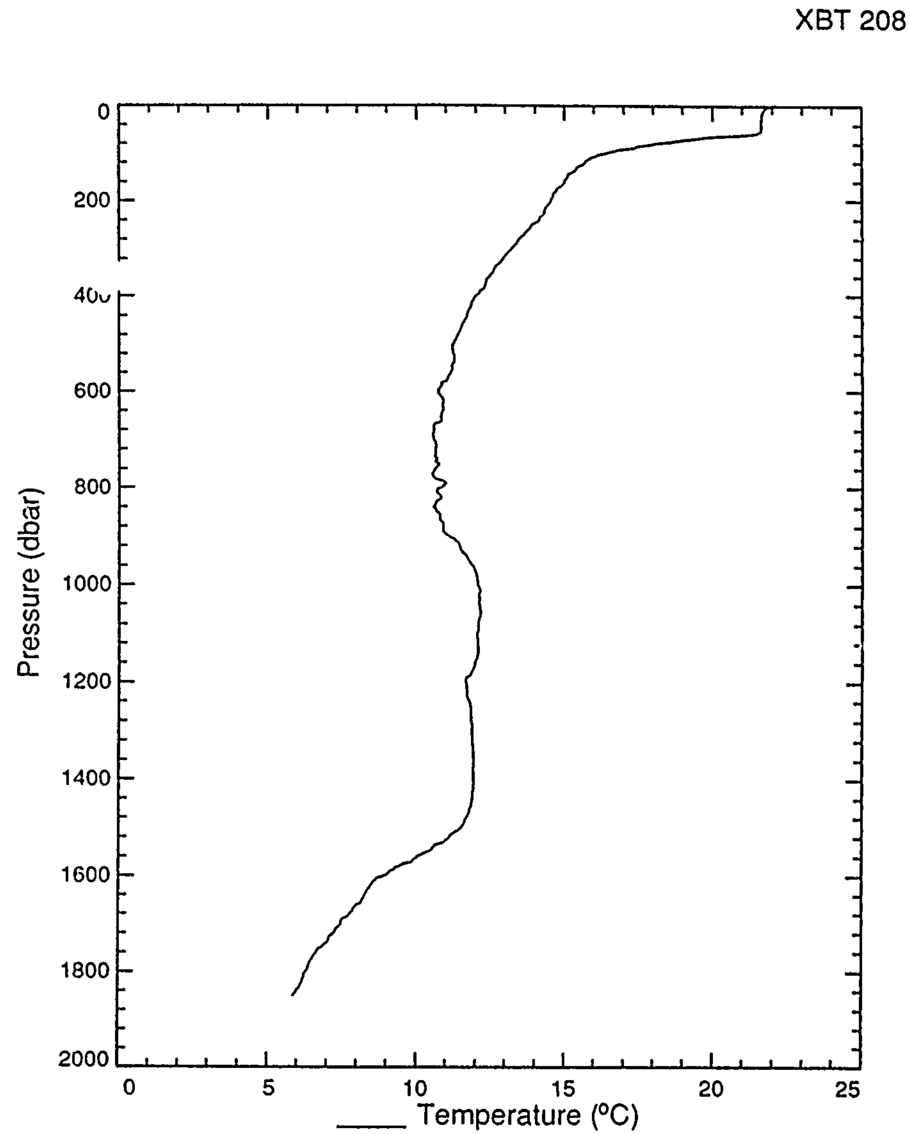
1800
2000
0
5
10
15
20
25
Temperature (ºC)


XBT 208
Pressure (dbar)
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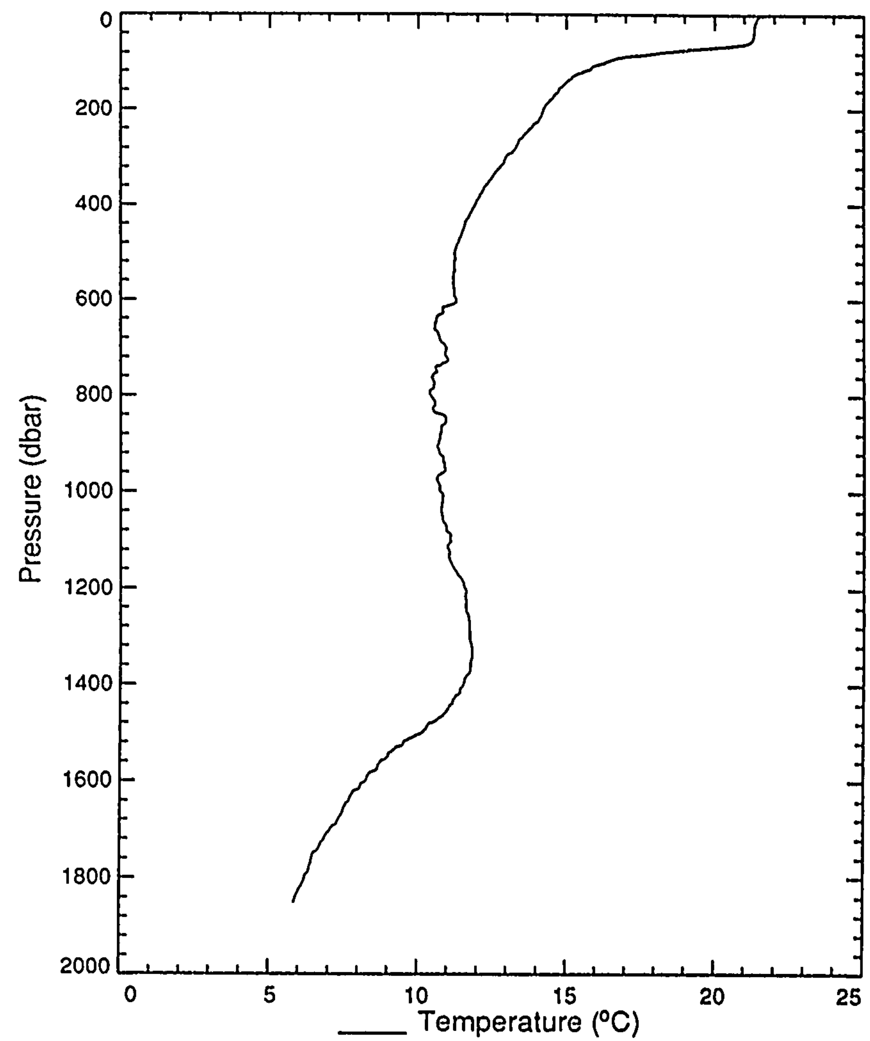
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
Temperature (ºC)

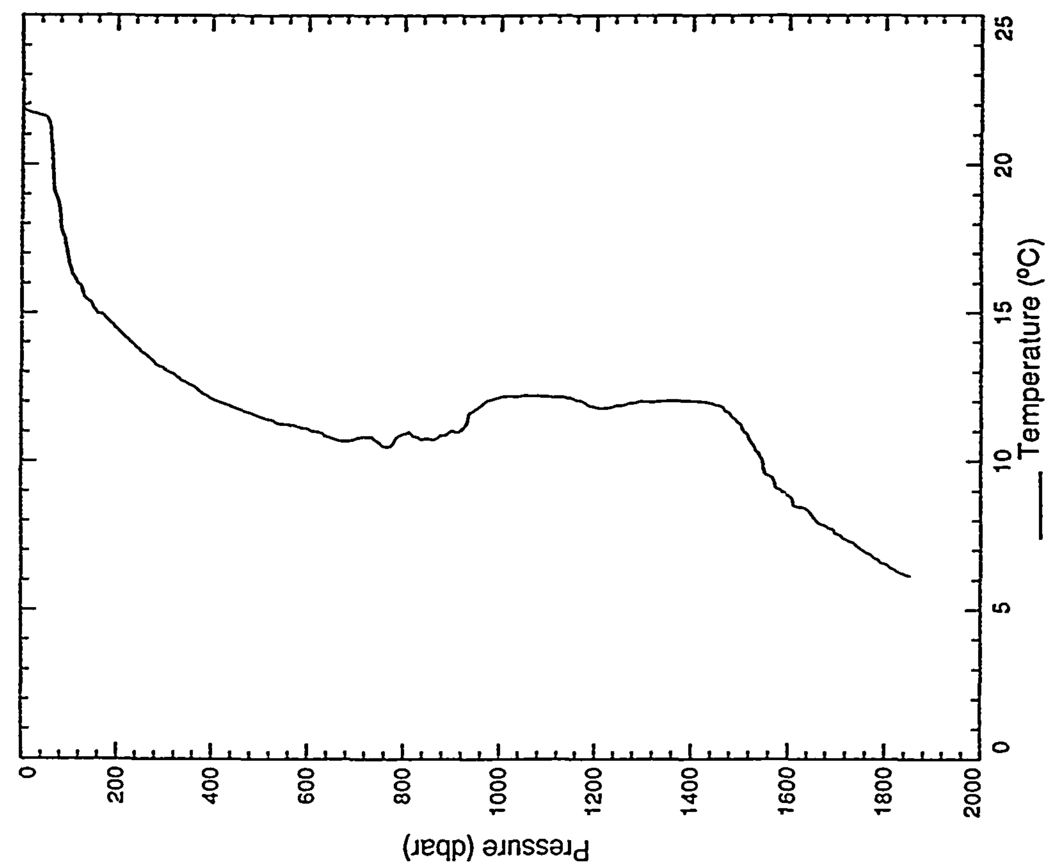
XBT 209

Bad Data

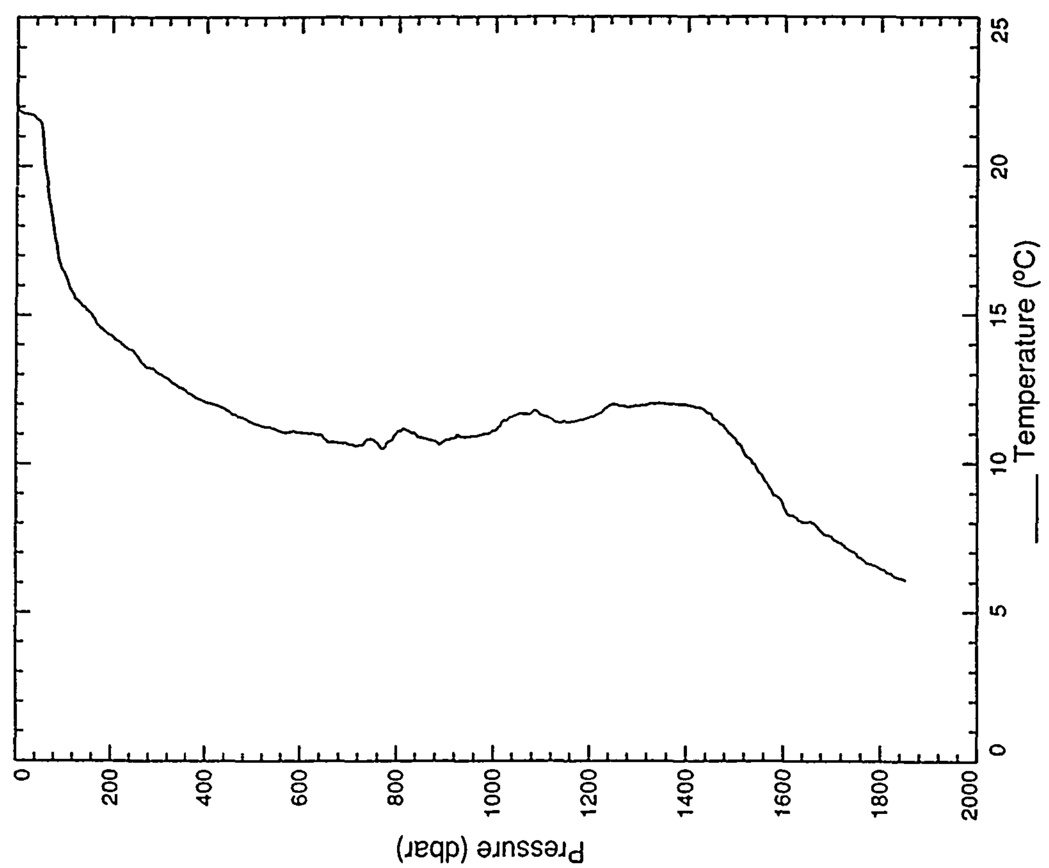
XBT 210



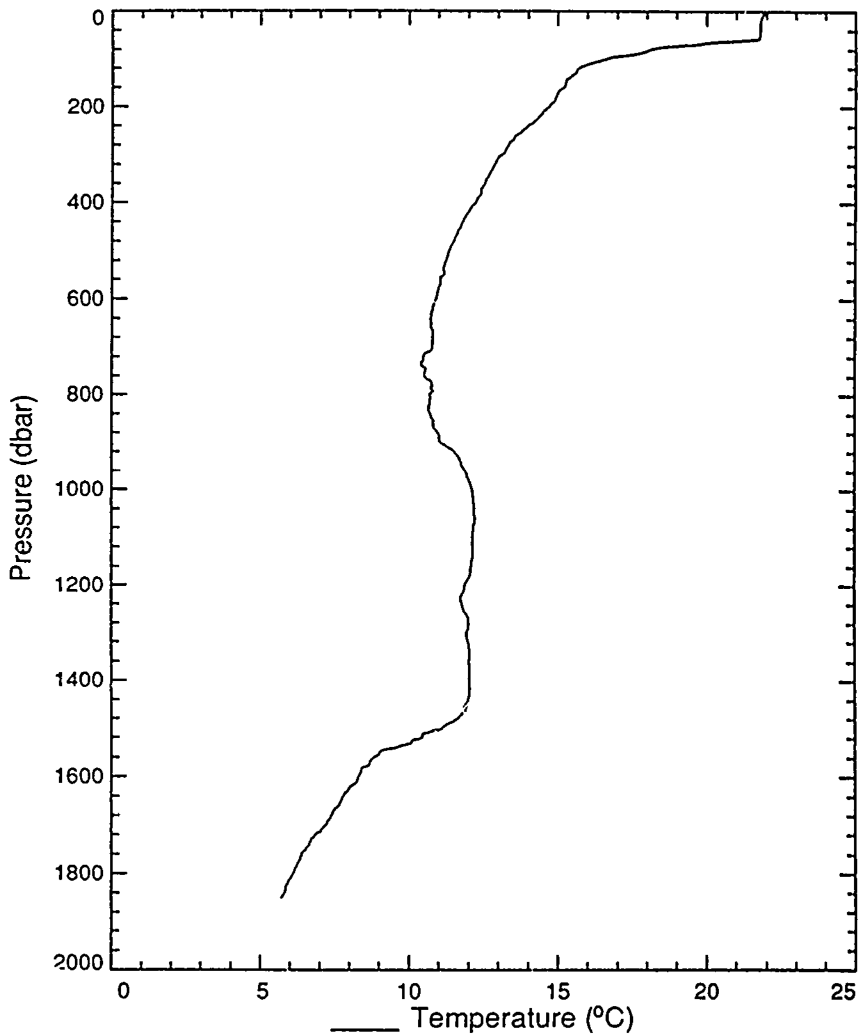
XBT 212



XBT 211



XBT 213



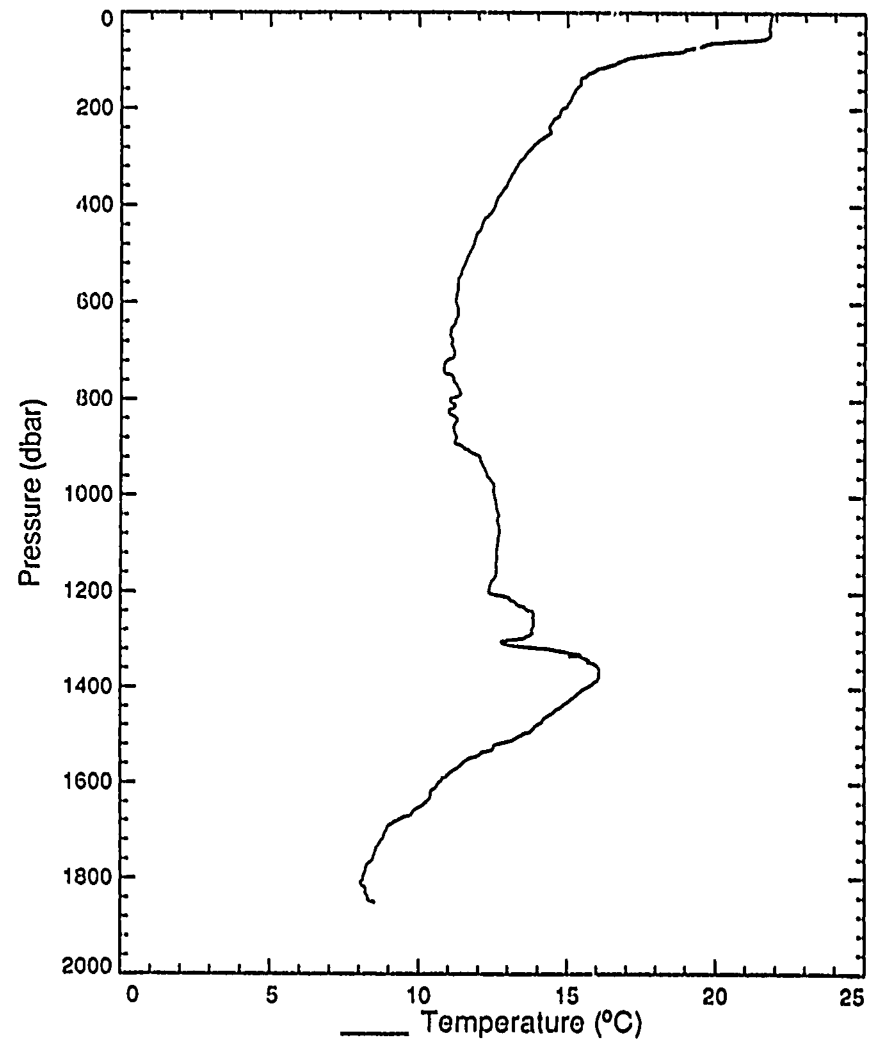
XBT 214

Bad Data

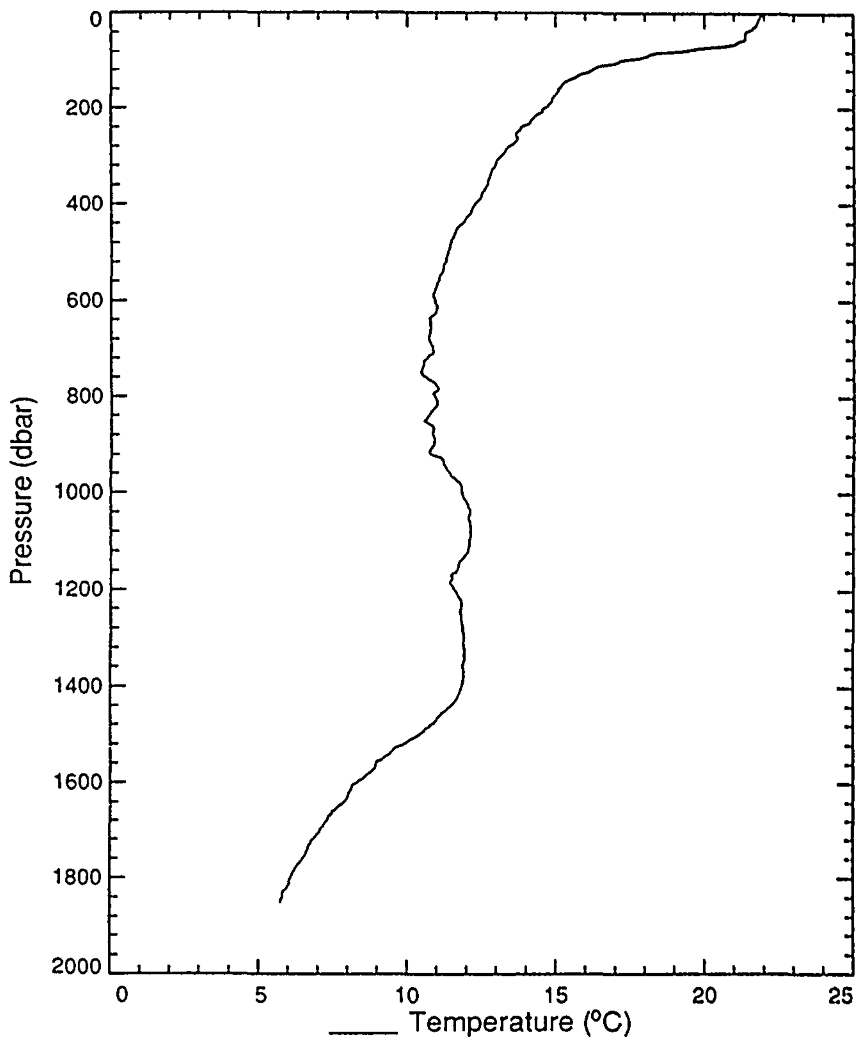
XBT 215

Off Scale

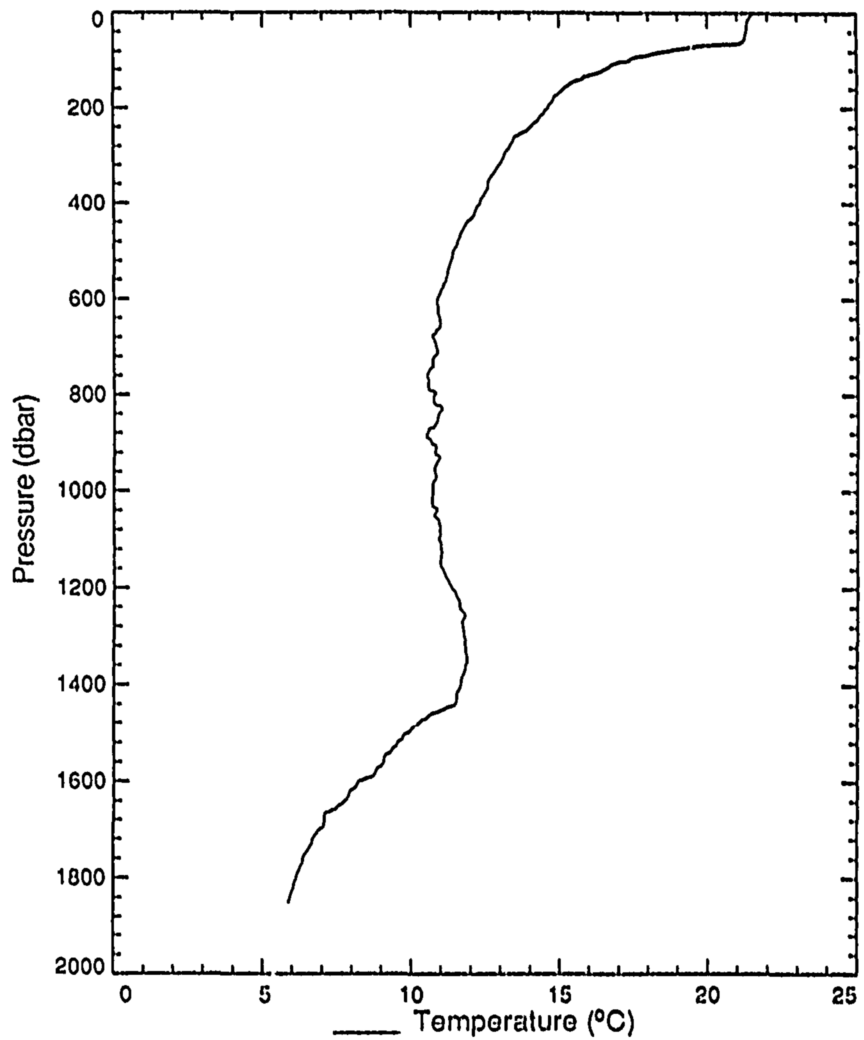
XBT 216



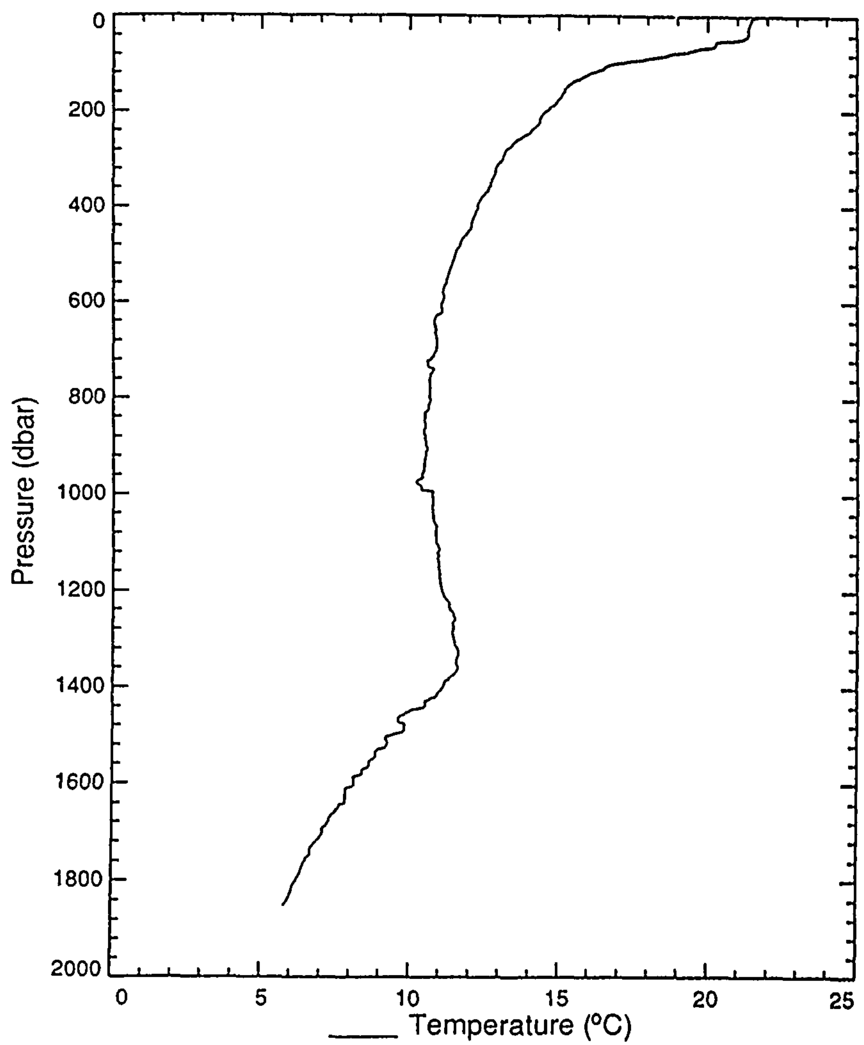
XBT 217



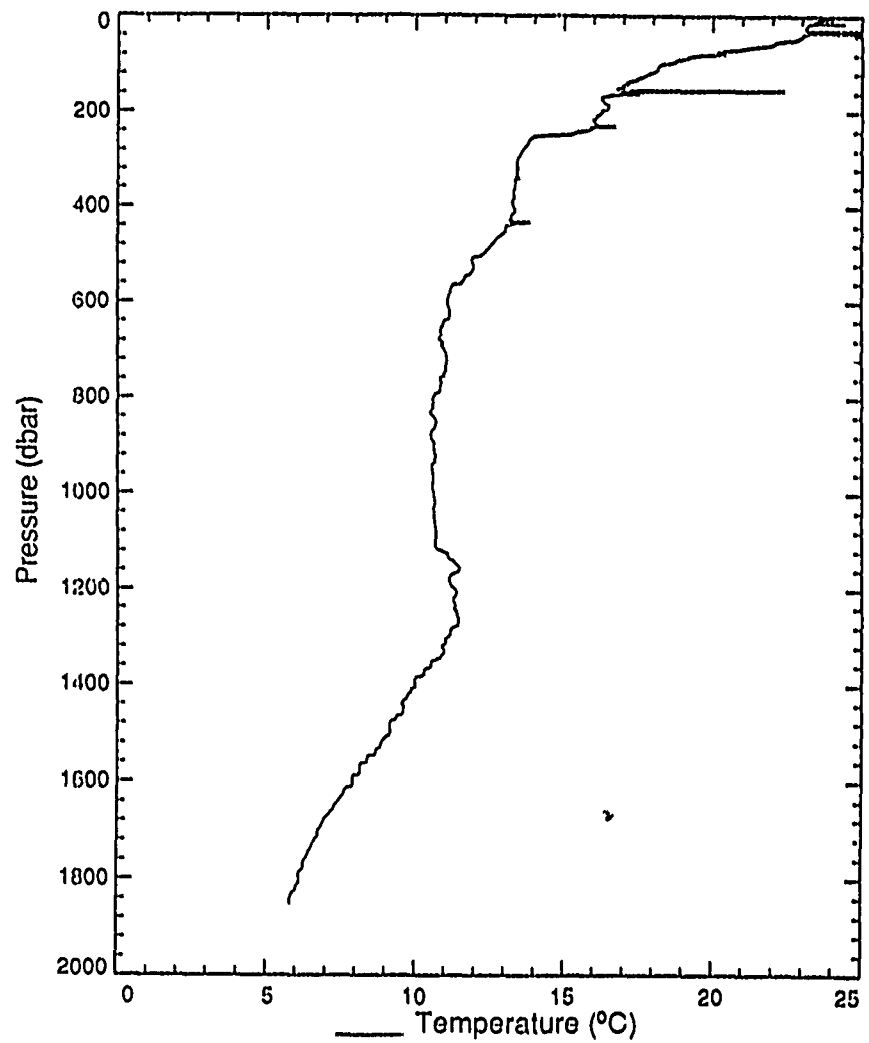
XBT 218



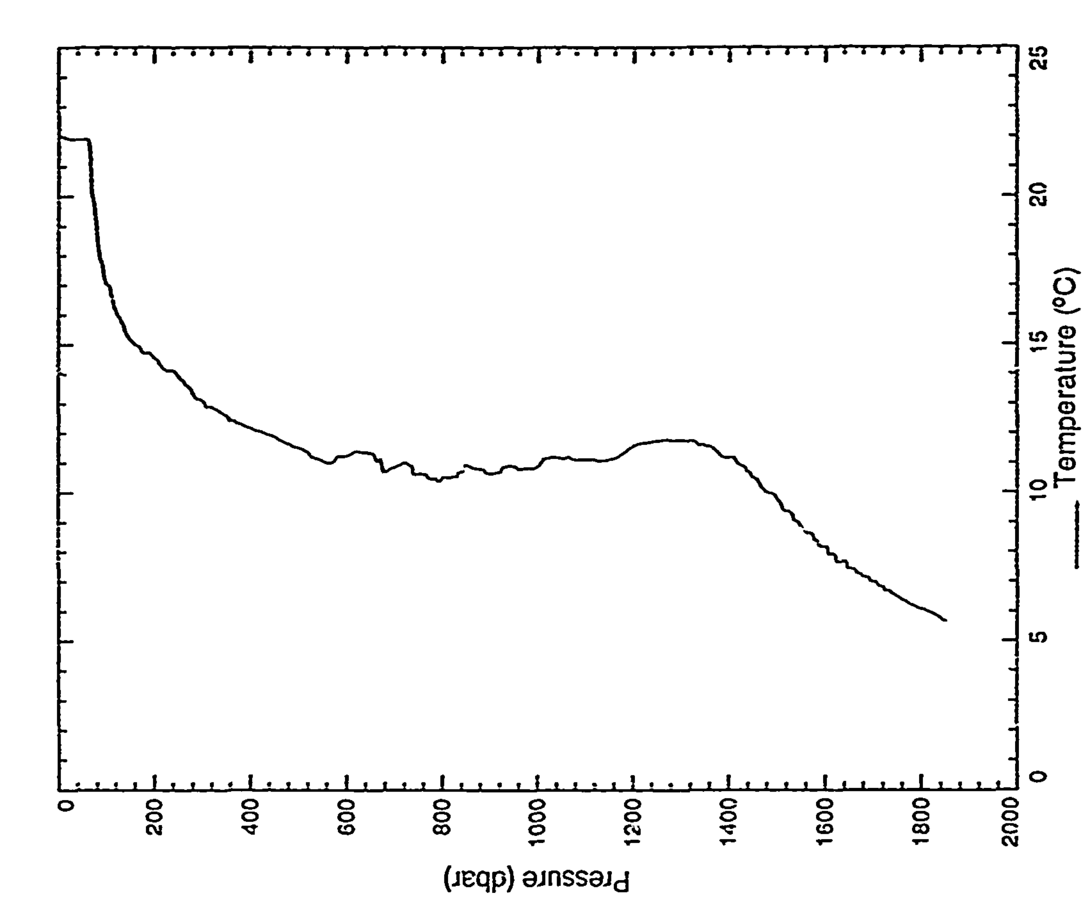
XBT 219



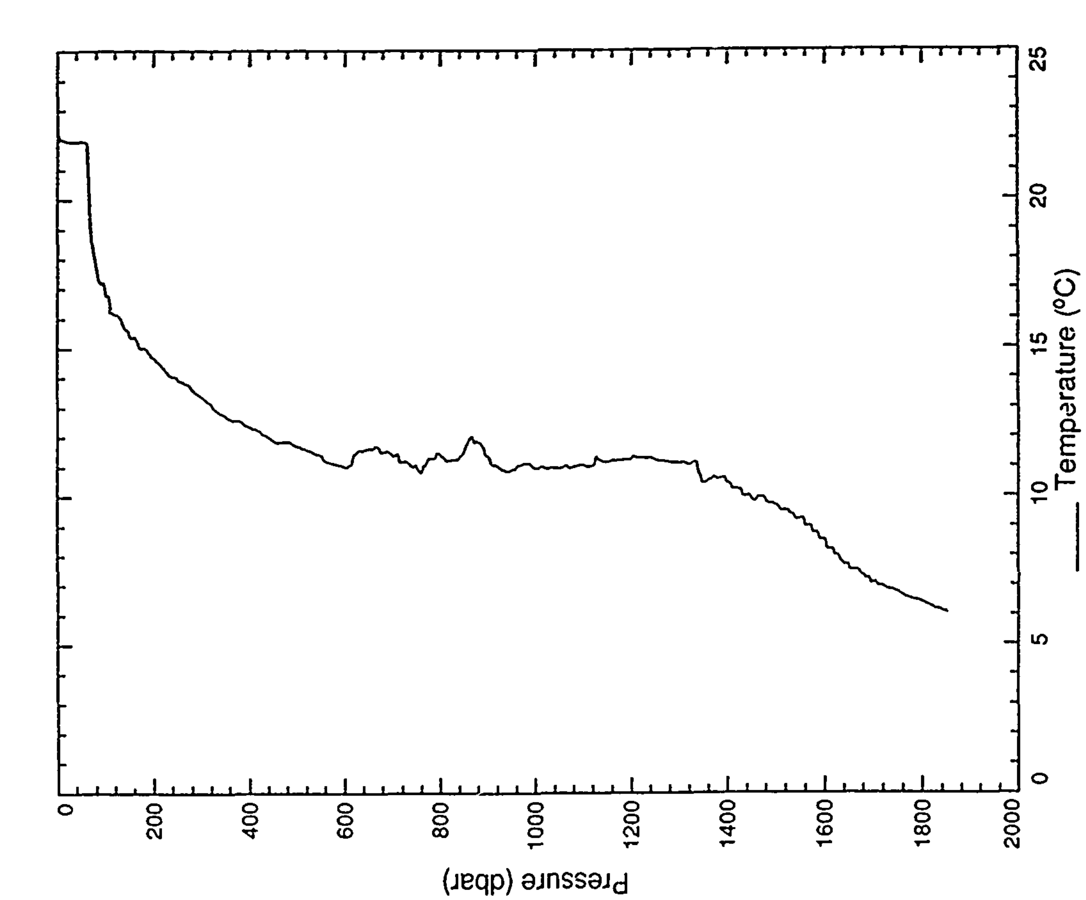
XBT 220

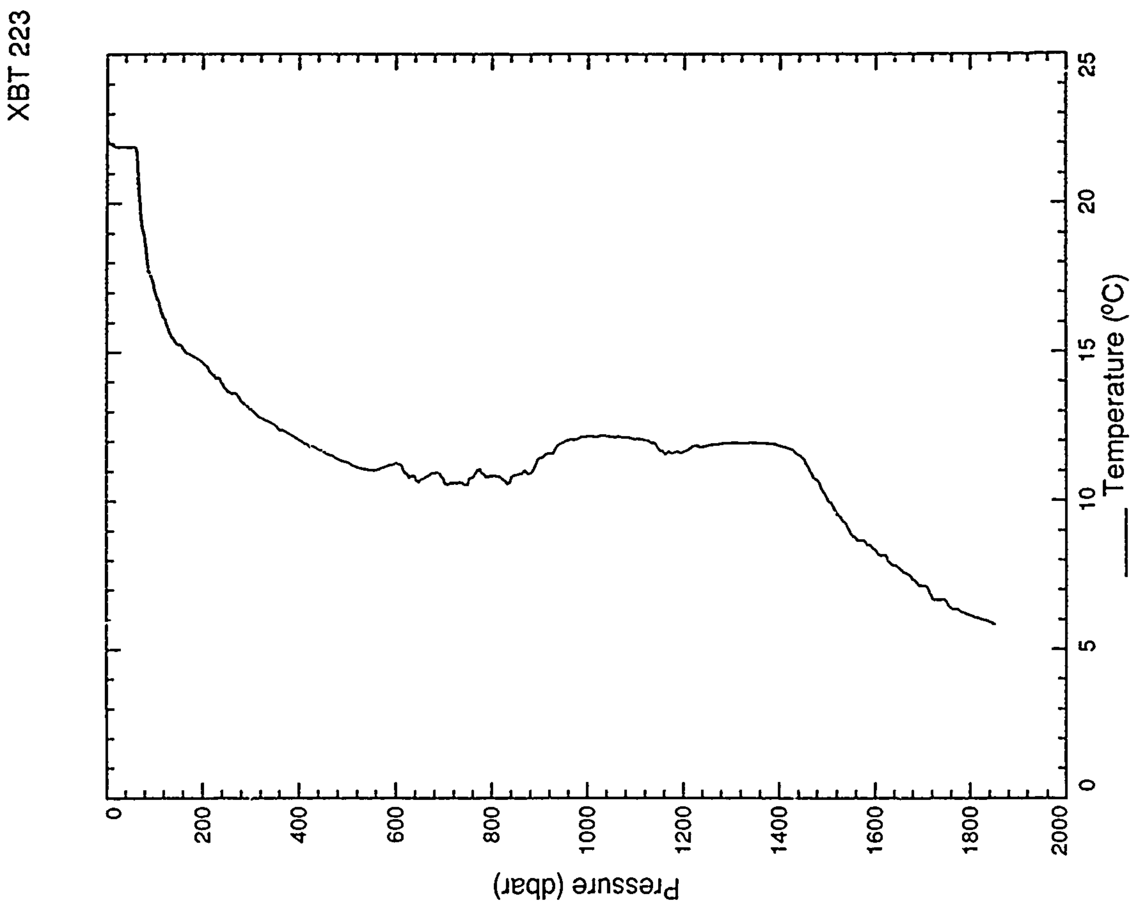


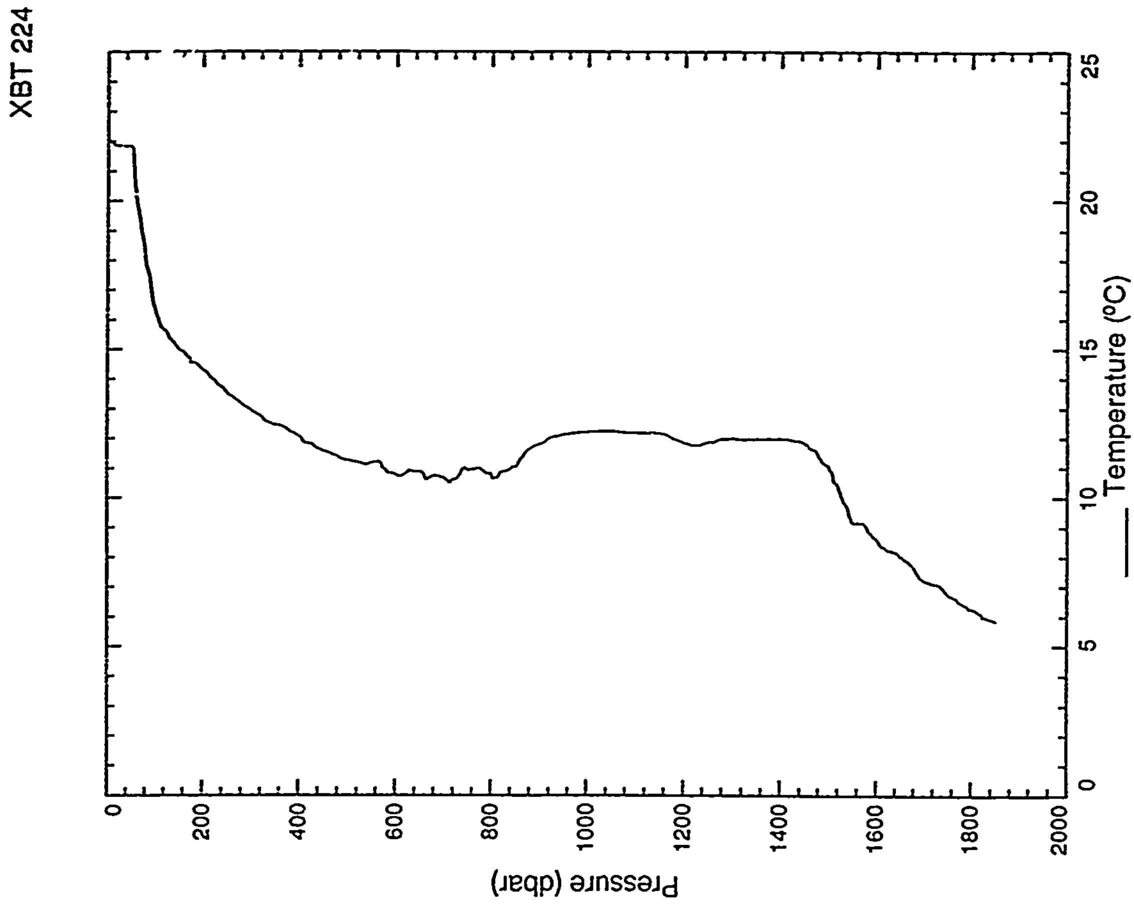
XBT 222



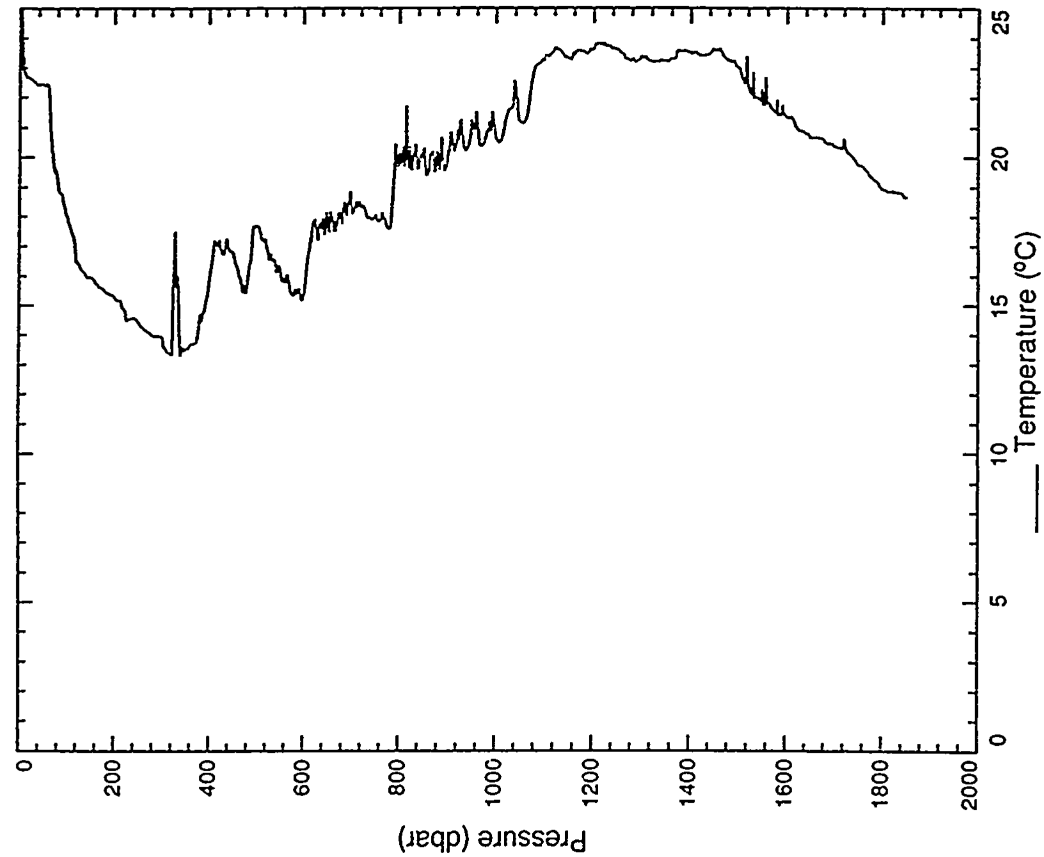
XBT 221



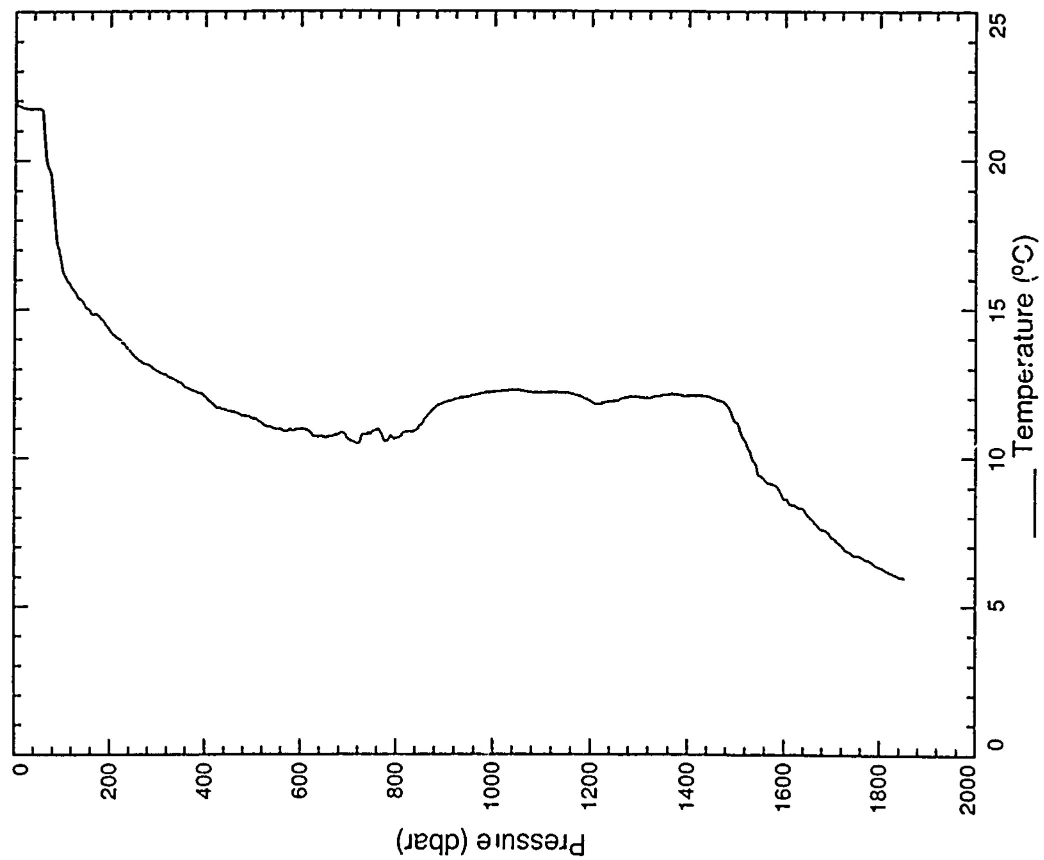

XBT 223
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25


XBT 224
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (ºC)
0
5
10
15
20
25

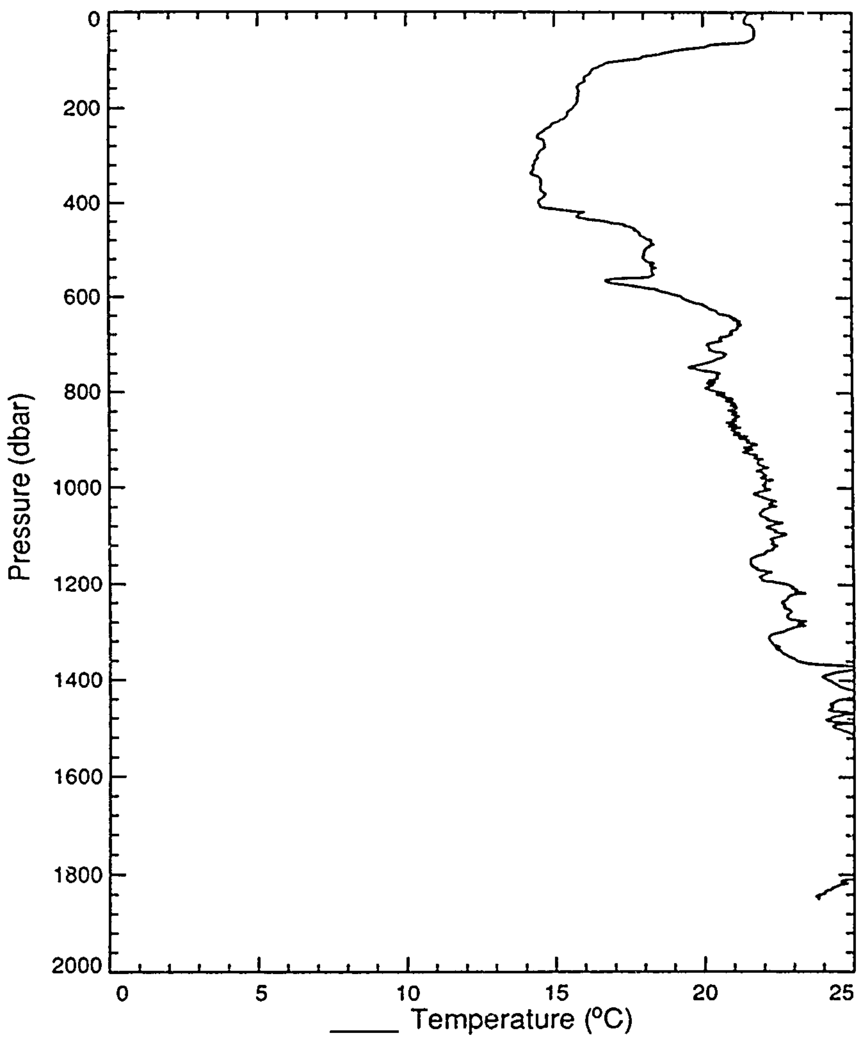
XBT 226



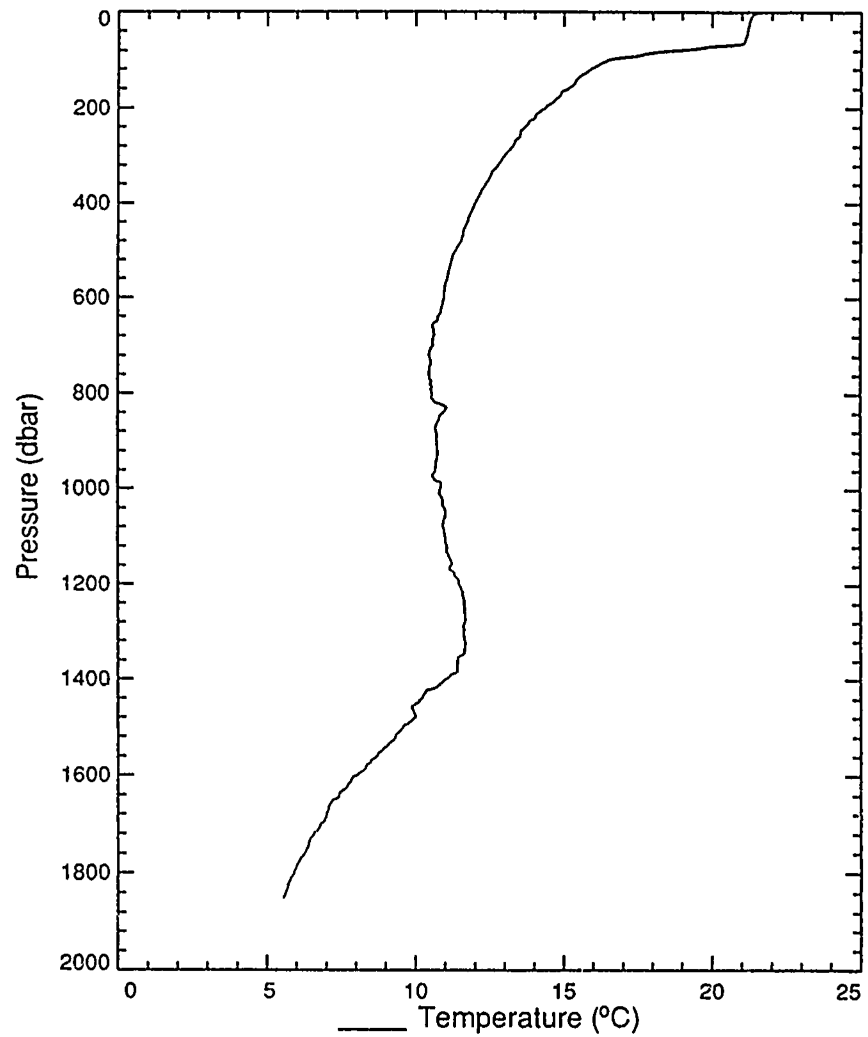
XBT 225



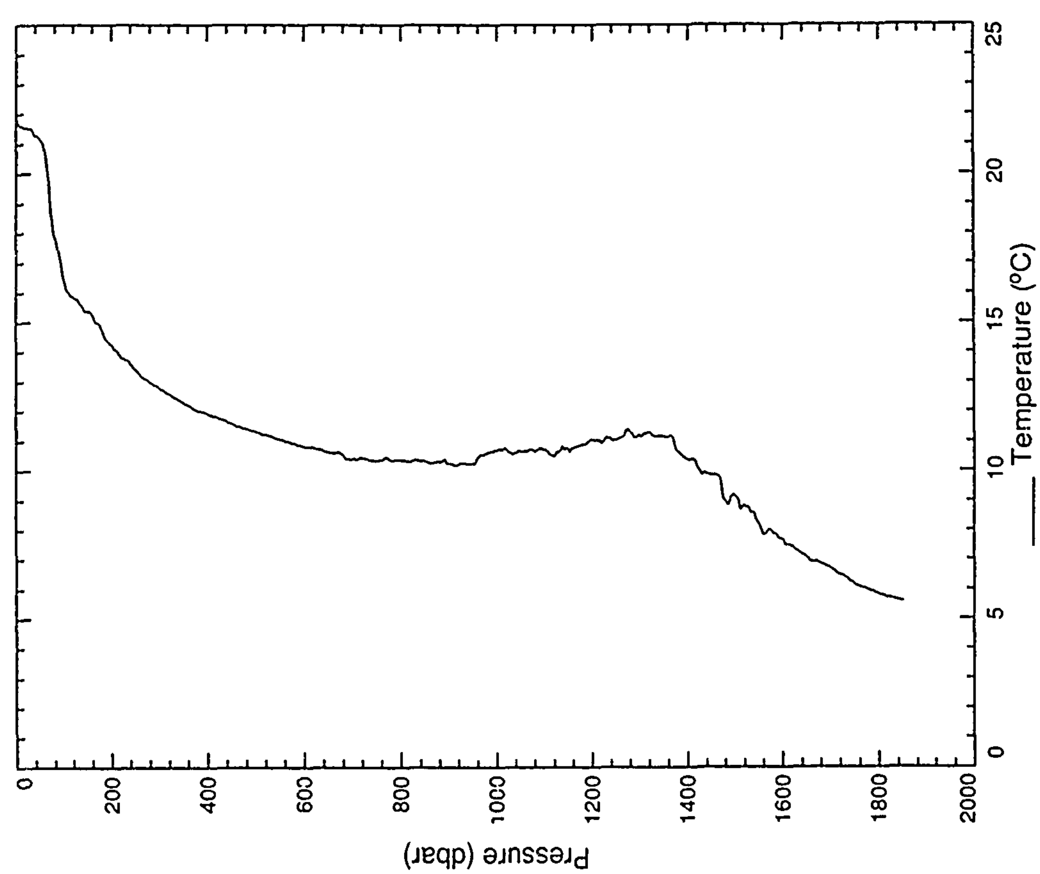
XBT 227



XBT 228



XBT 229


0
5
10
15
20
25
Temperature (ºC)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Pressure (dbar)

APPENDIX D

Profiles of Sound Speed versus Pressure

Type 02 XSV depths were corrected and converted to pressure in the following manner. First, we solved for time of fall by inverting the fall rate equation to obtain

$$t = \frac{-\text{pcal1} + \sqrt{\text{pcal1}^2 - 4(\text{pcal2})(\text{pcal0} + \text{XSV depth})}}{2\text{pcal2}},$$

where these pcal's are Sippican's XSV fall rate coefficients and have the values

pcal0 = 0.0
pcal1 = 5.5895
pcal2 = −0.00147.

Then we computed the new depth from time.

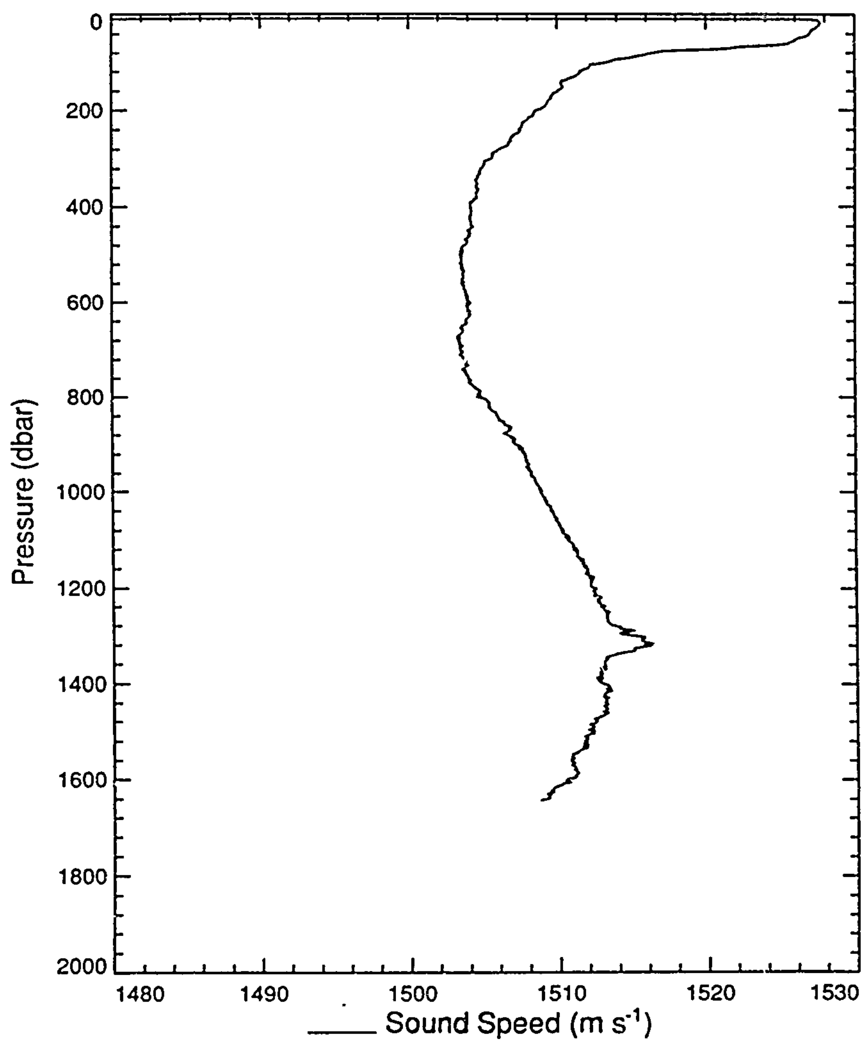
$$\text{New XSV depth} = -[(\text{pcal0} + (\text{pcal1} \times t) + (\text{pcal2} \times t^2)],$$

where these pcal's are the Cadiz cruise XSV coefficients determined in Section 5.1 and have the values

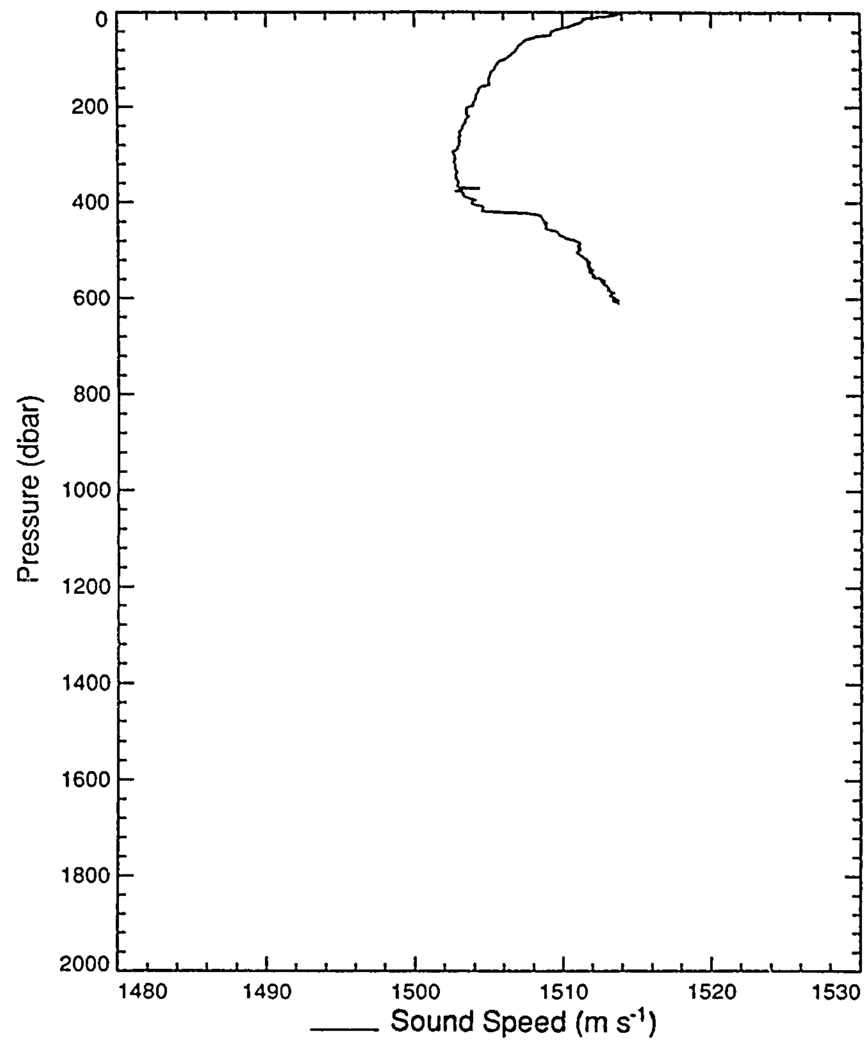
pcal0 = 3.38
pcal1 = 5.8561
pcal2 = −0.000883.

The "new XSV depths" were then converted to pressure in the same manner as the XBT depths. The type 03 XSV depths were not corrected; only the conversion to pressure was made. The sound speeds for both the type 02s and 03s were adjusted by adding 0.2 m s^{-1}. The data were then gridded into 2 dbar values. The graphs have been terminated at the end of good data.

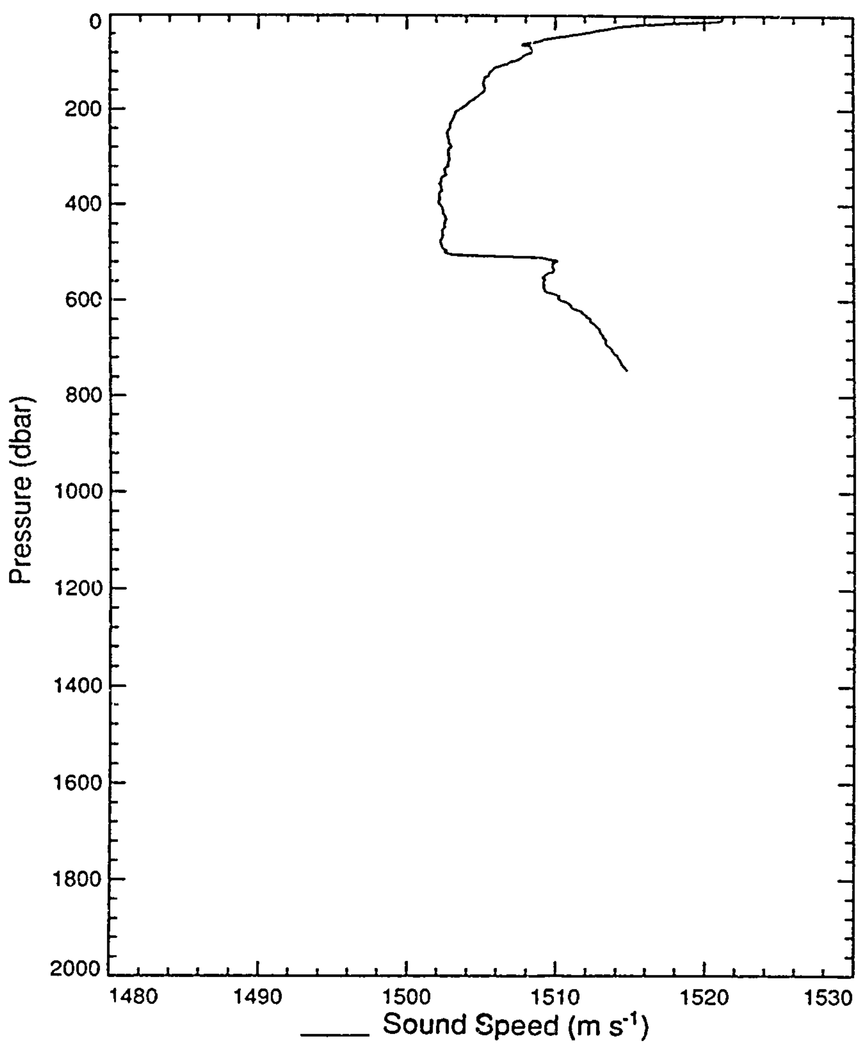
XSV 005



XSV 008

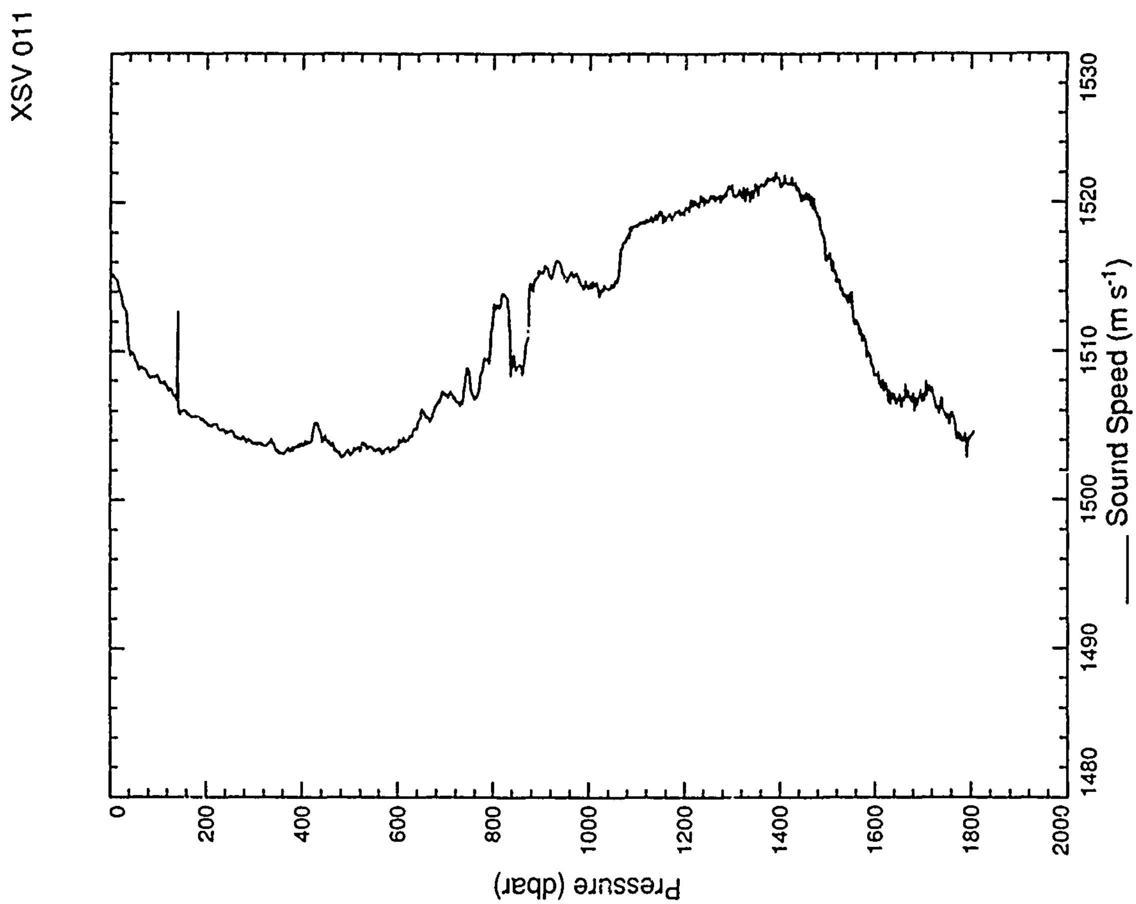


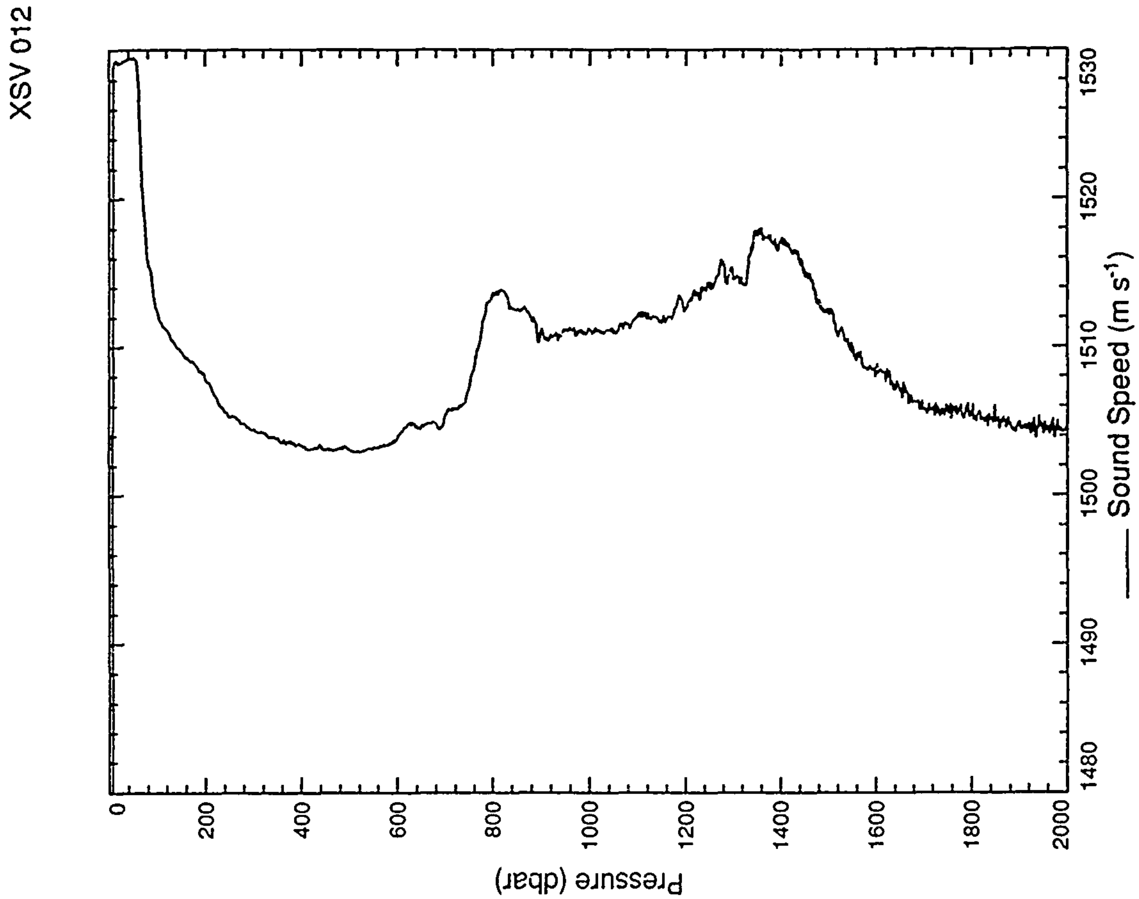
XSV 009



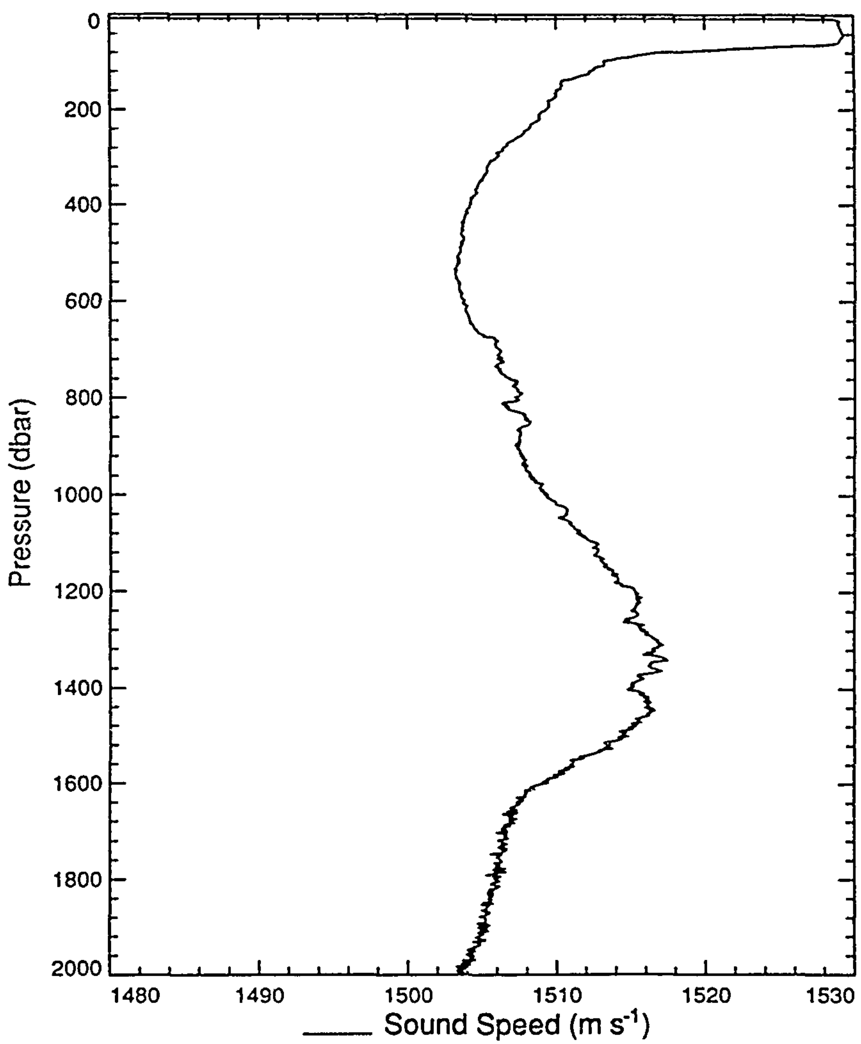
XSV 010

No Data

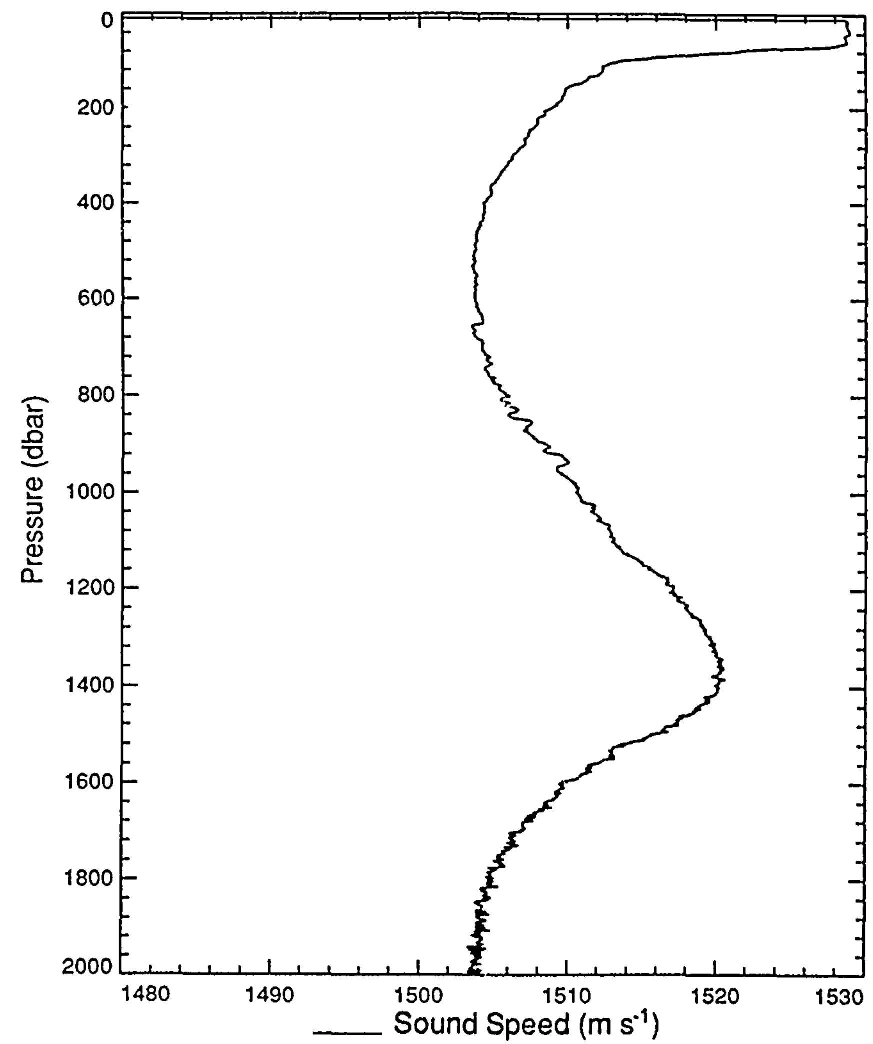

XSV 011
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

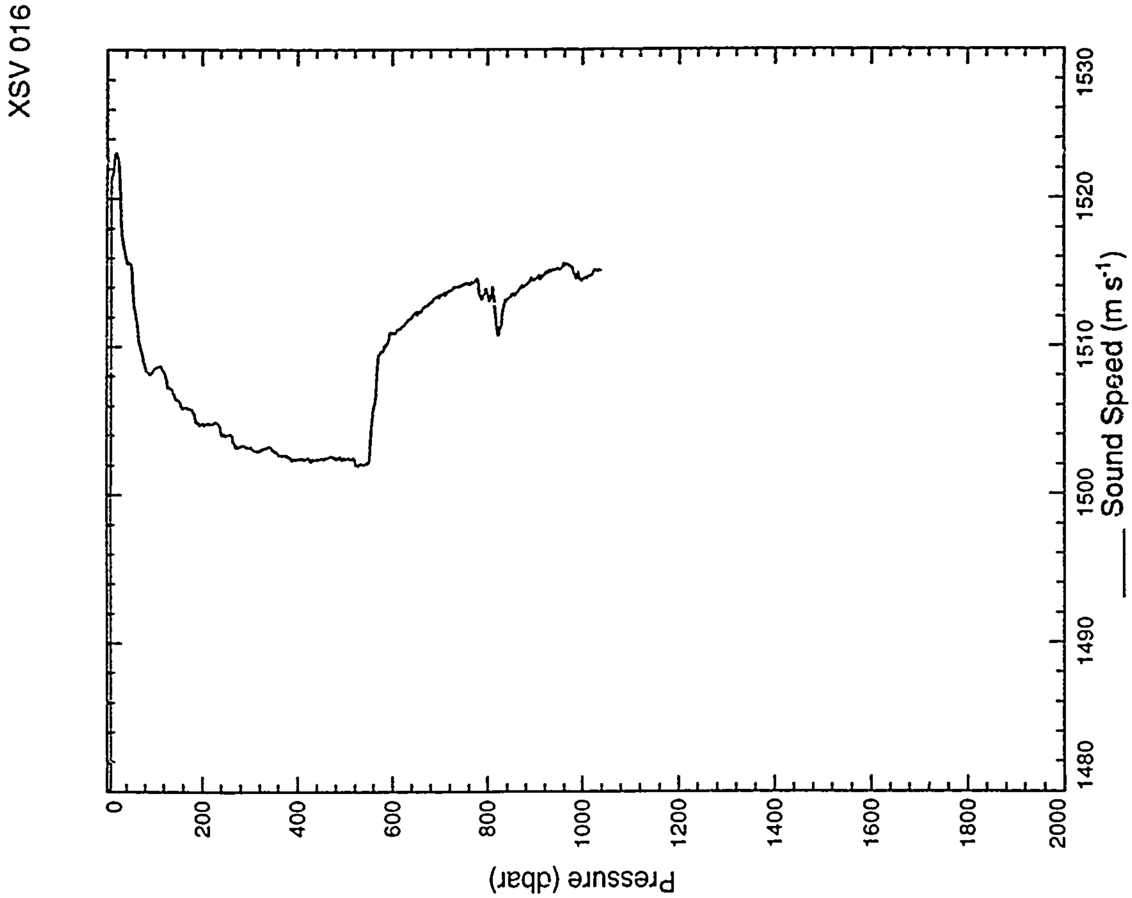

XSV 012
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

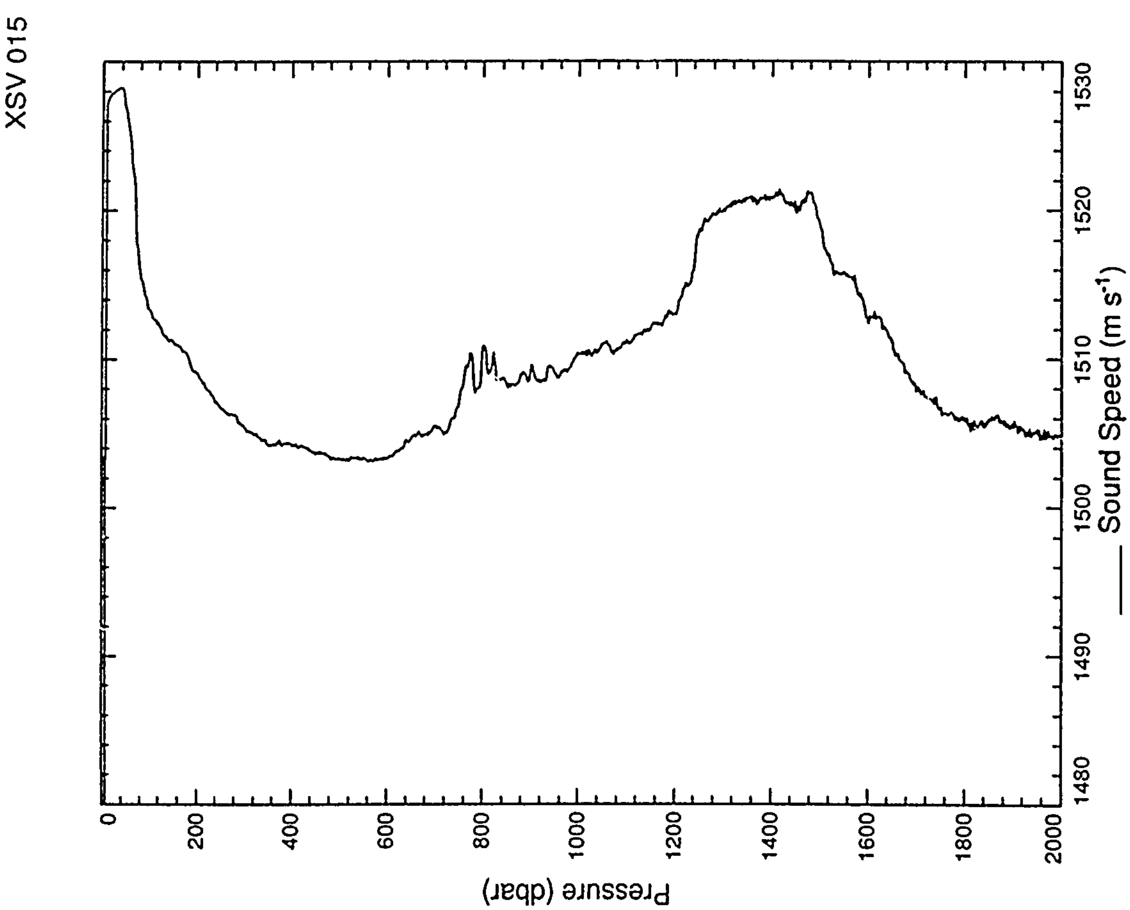
XSV 013



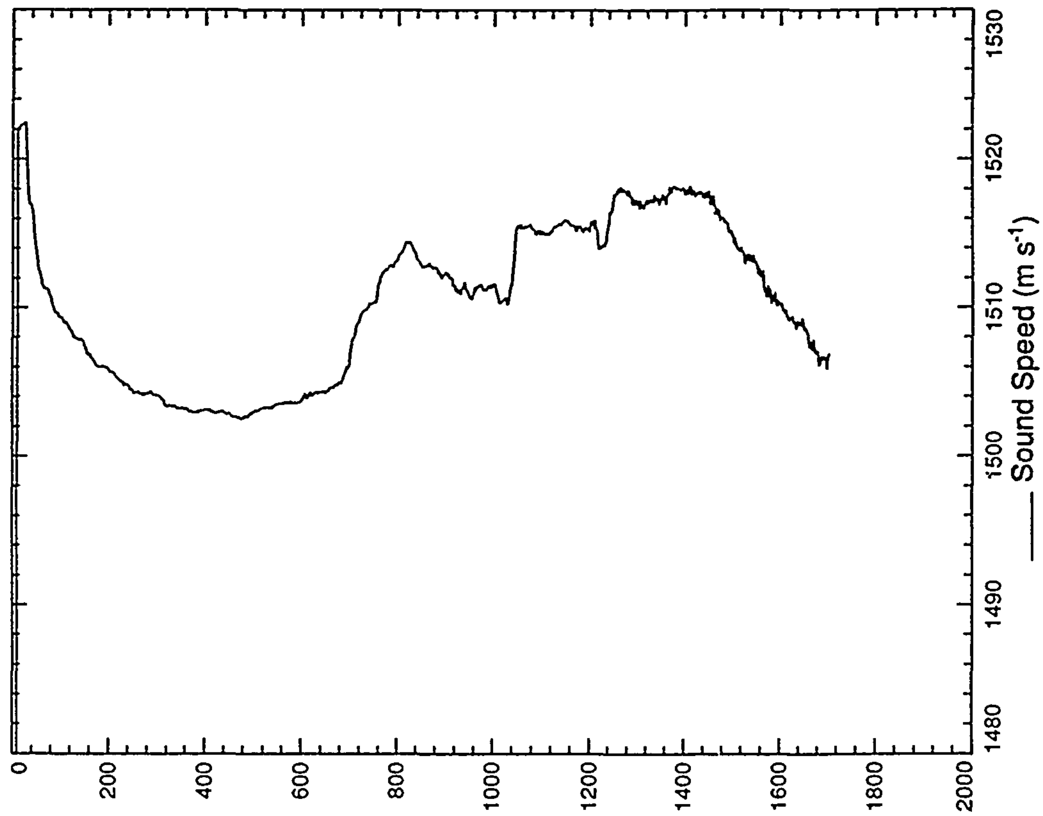
XSV 014



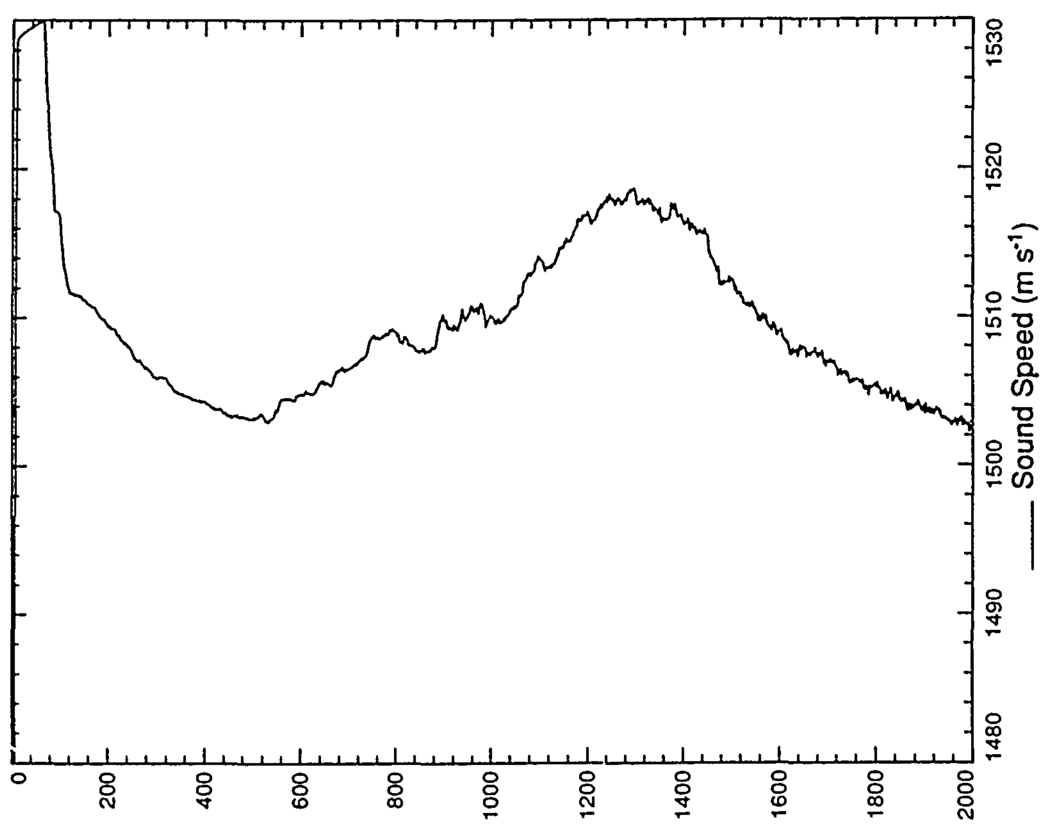

XSV 016
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s^{-1})
1480
1490
1500
1510
1520
1530

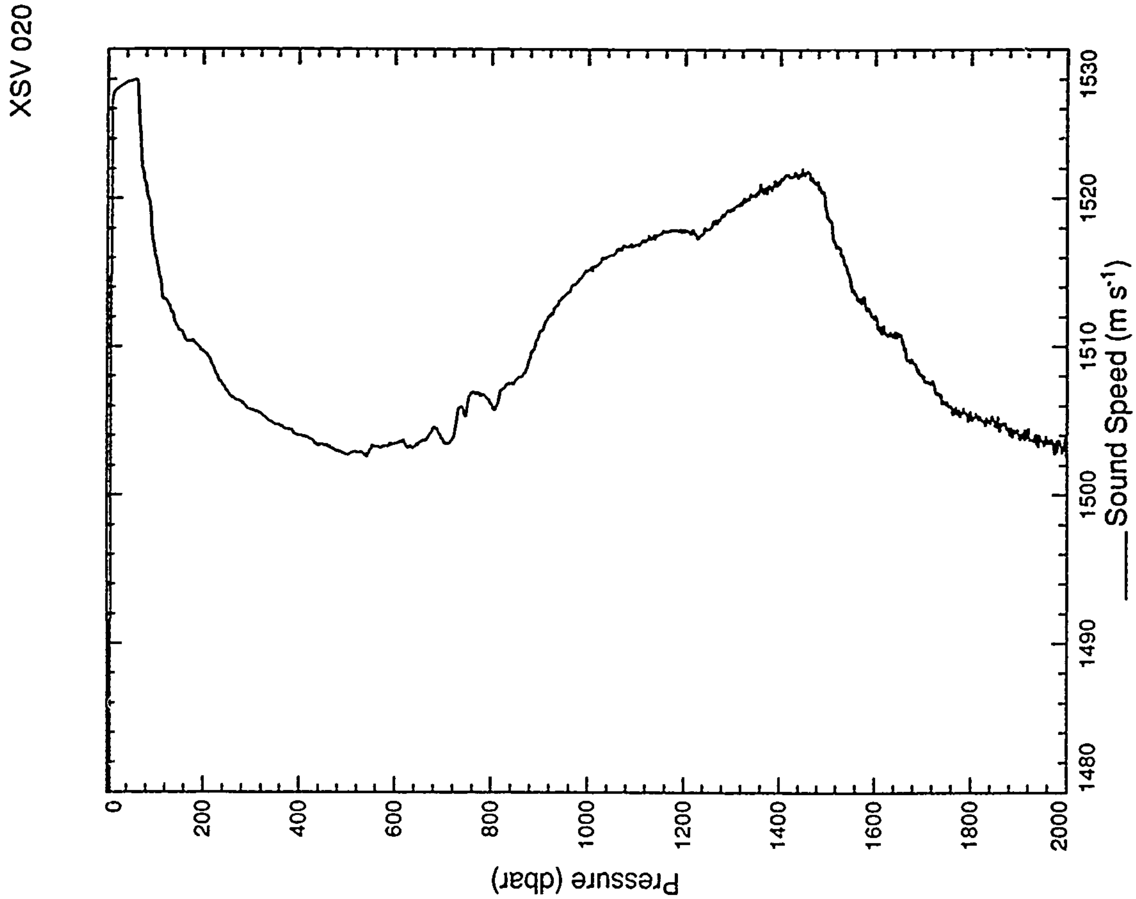

XSV 015
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s^{-1})
1480
1490
1500
1510
1520
1530

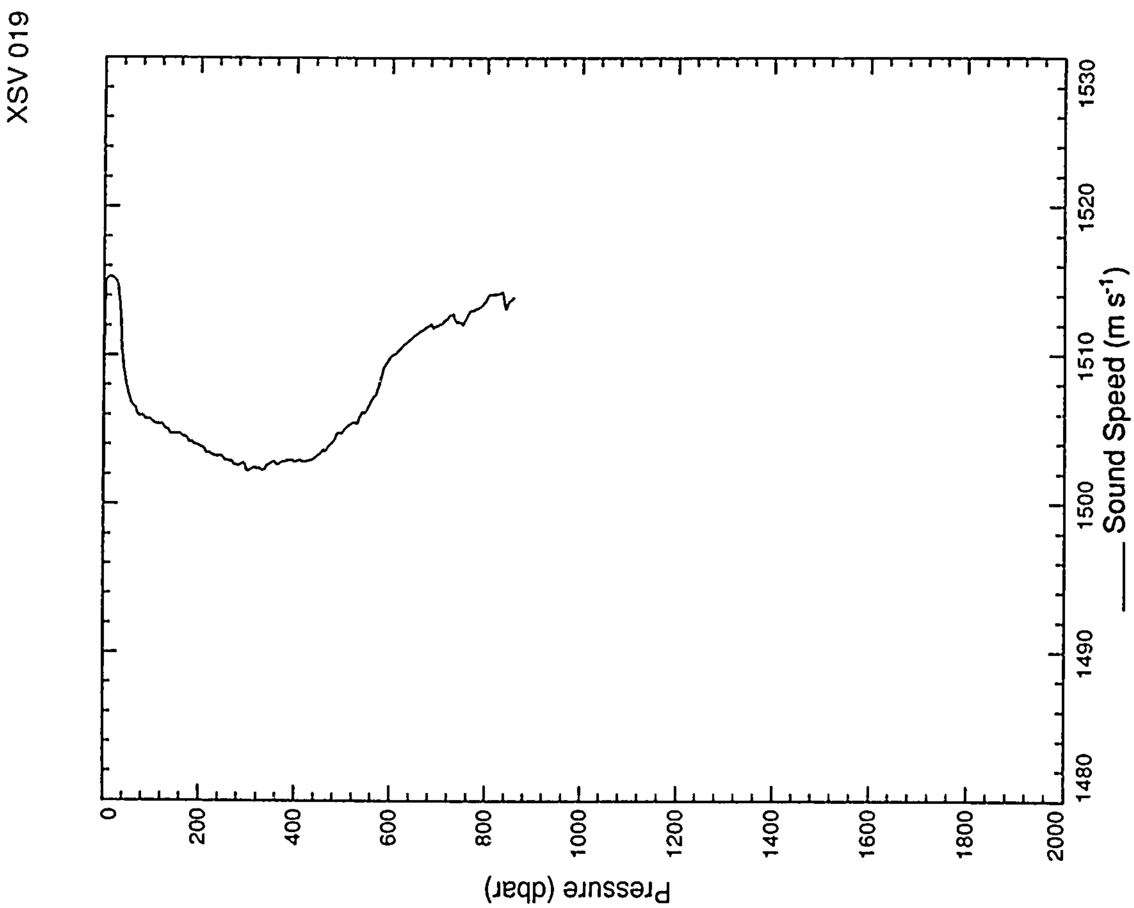
XSV 018



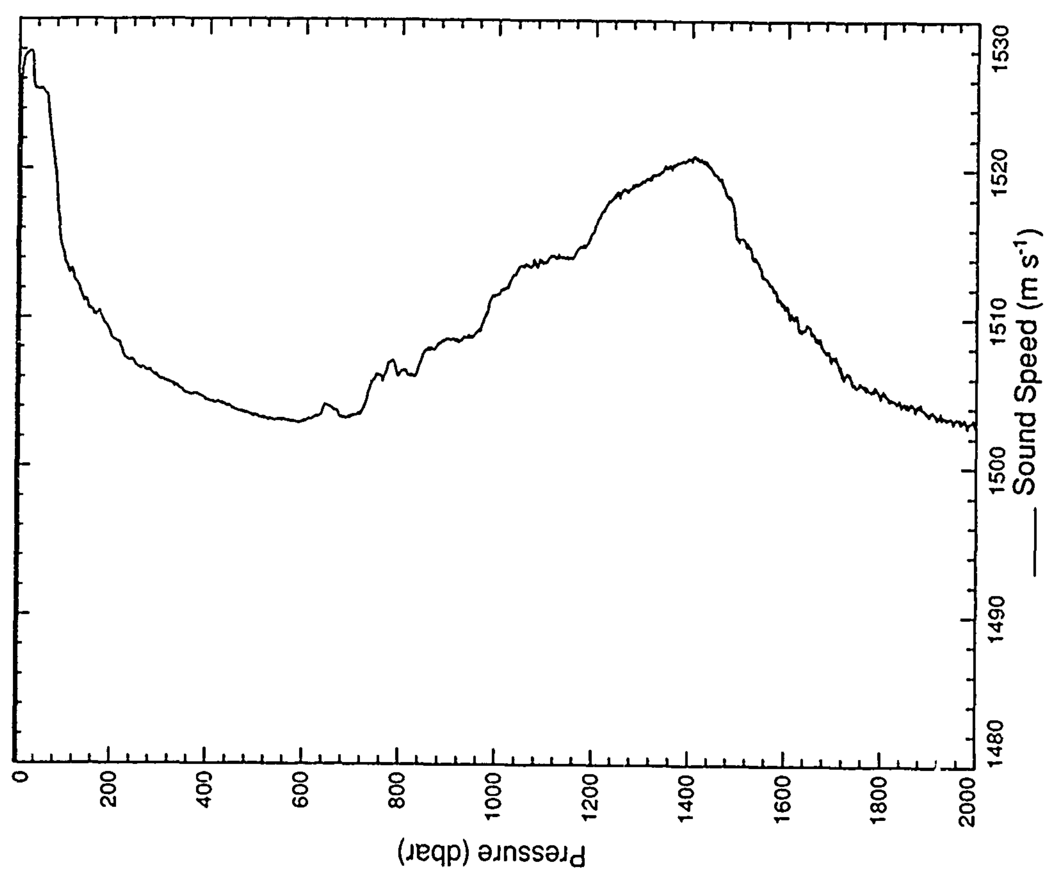
XSV 017



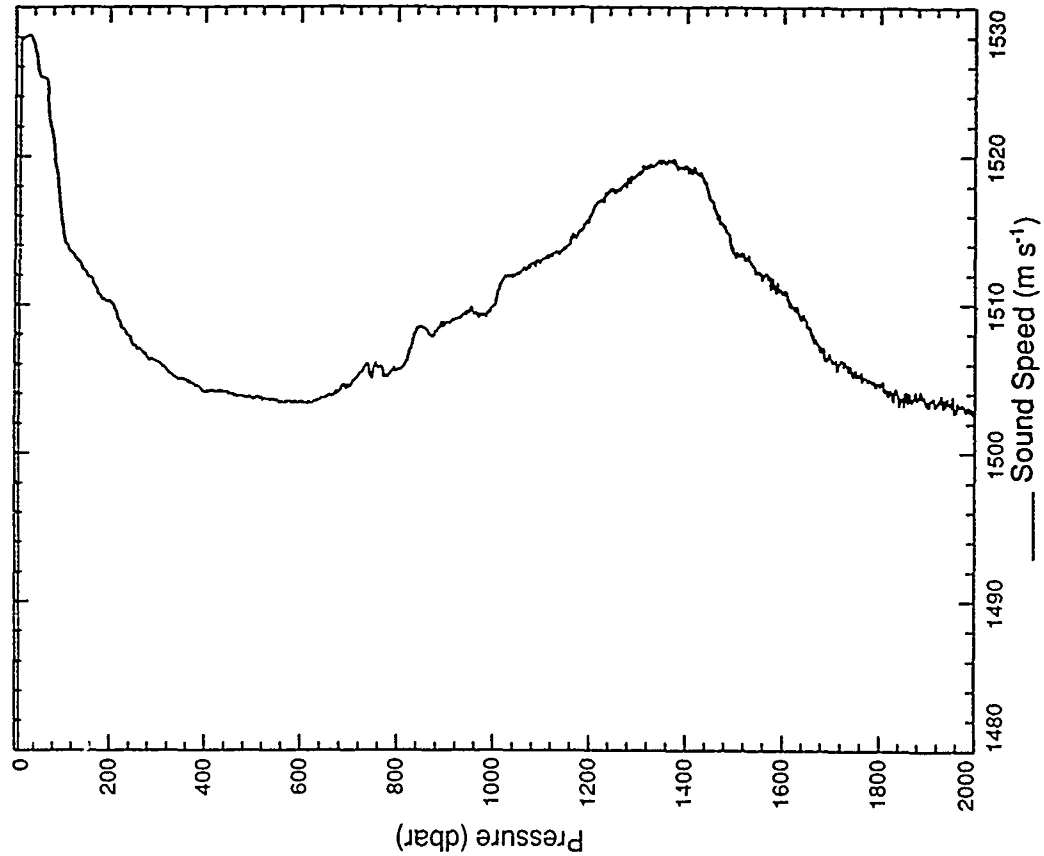

XSV 020
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

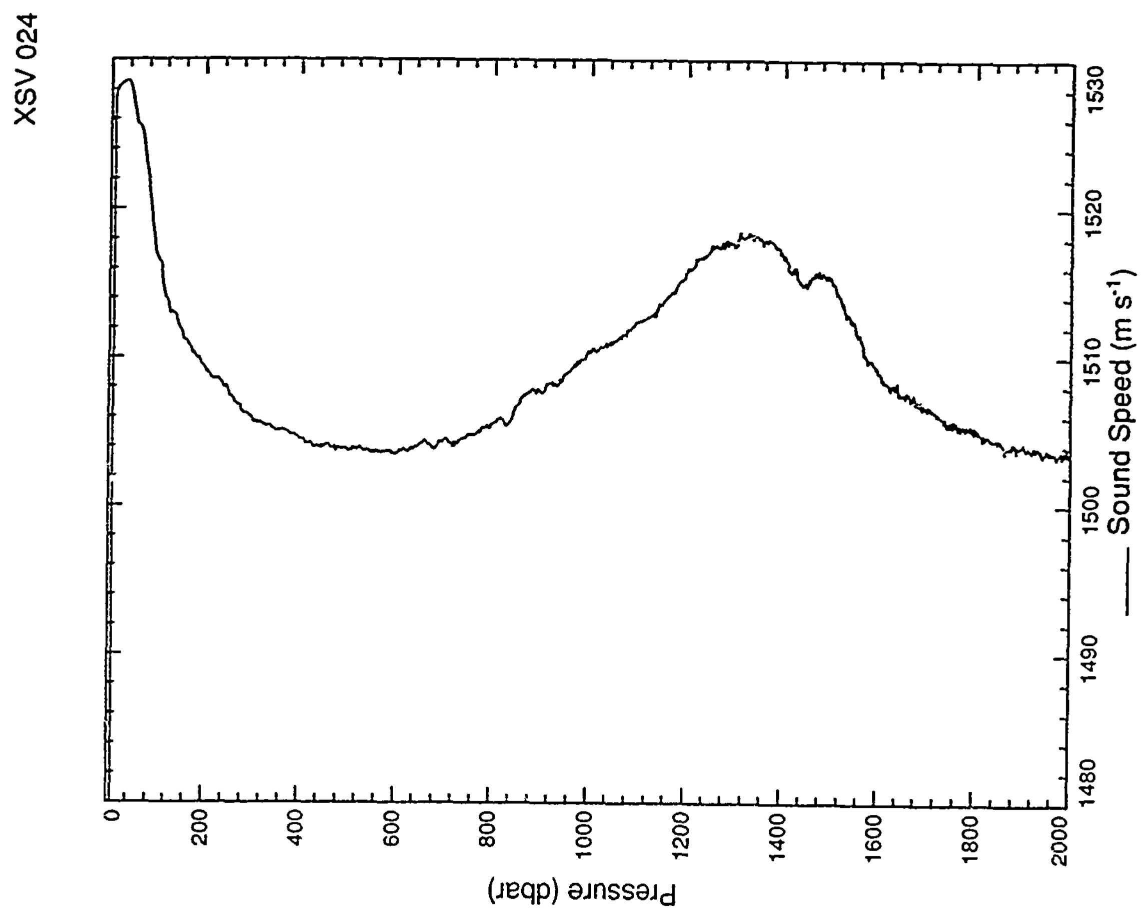

XSV 019
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

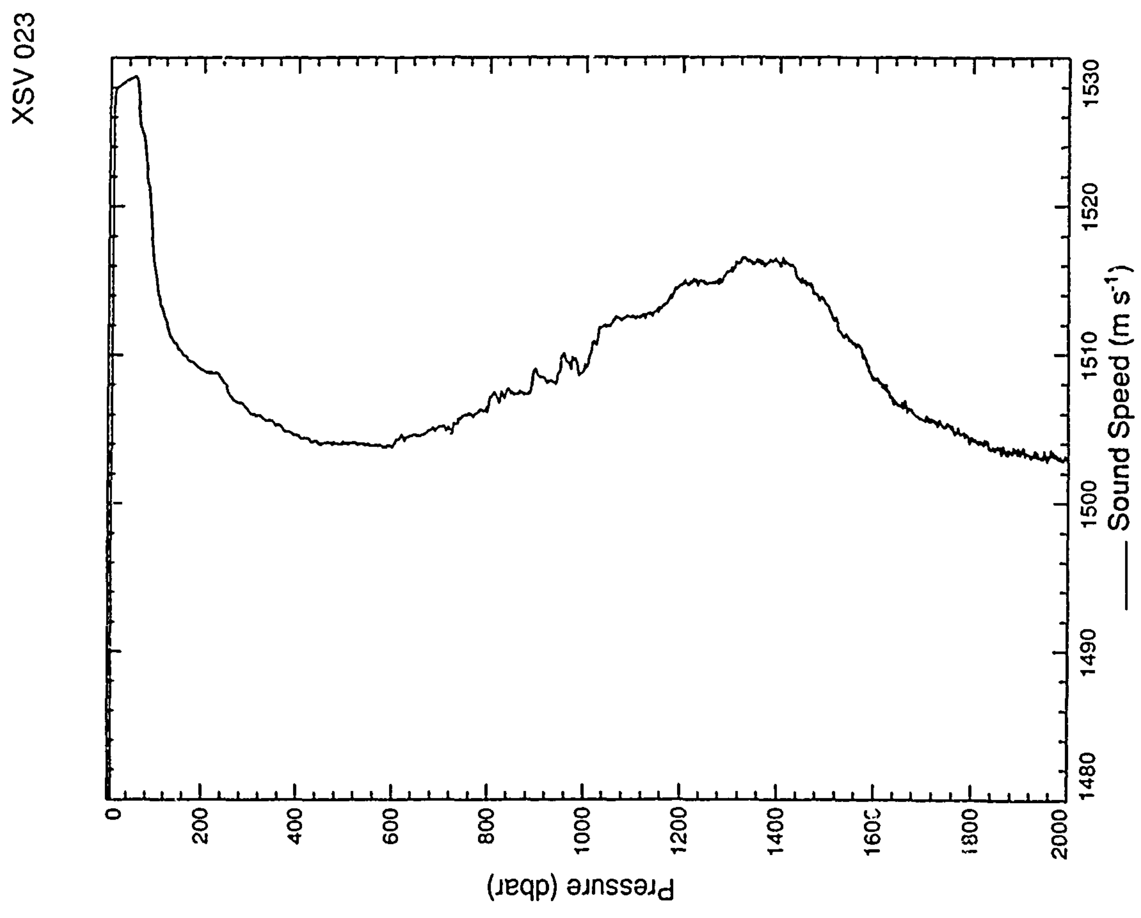
XSV 021

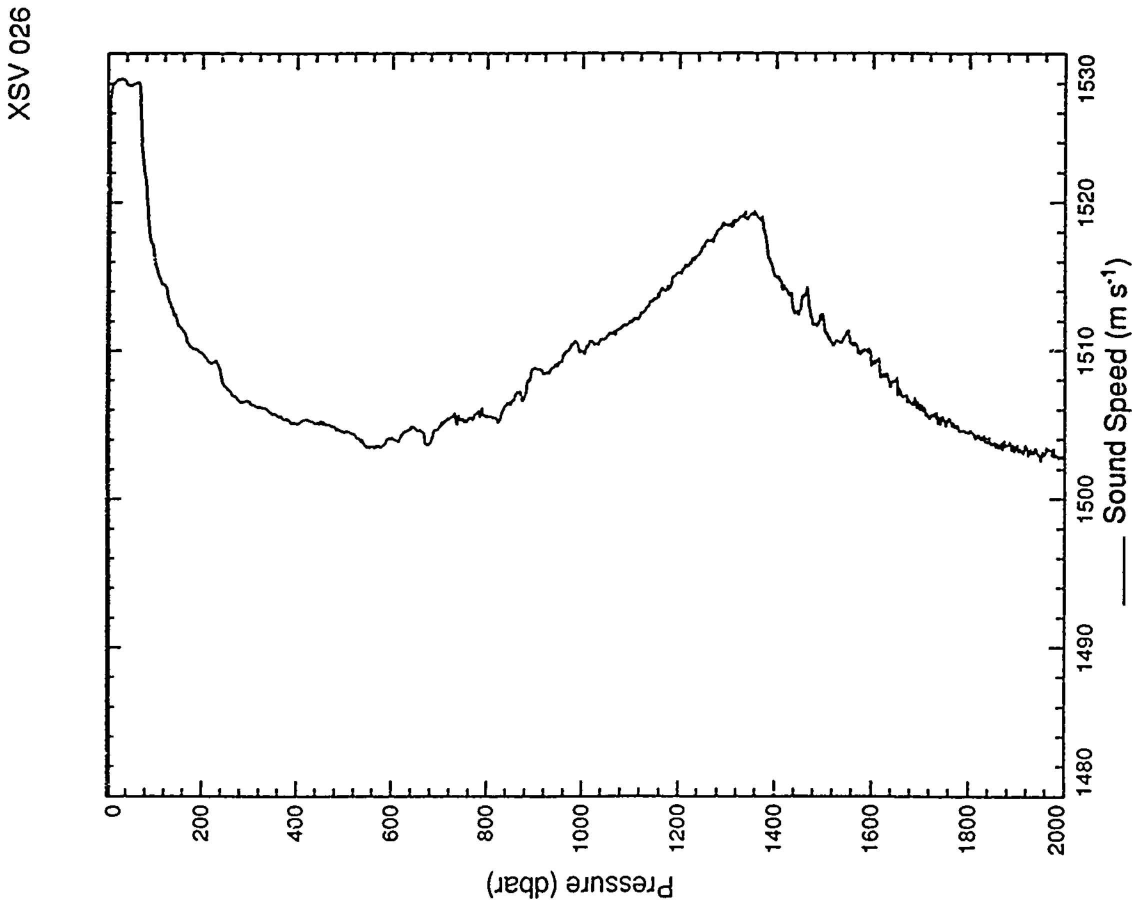


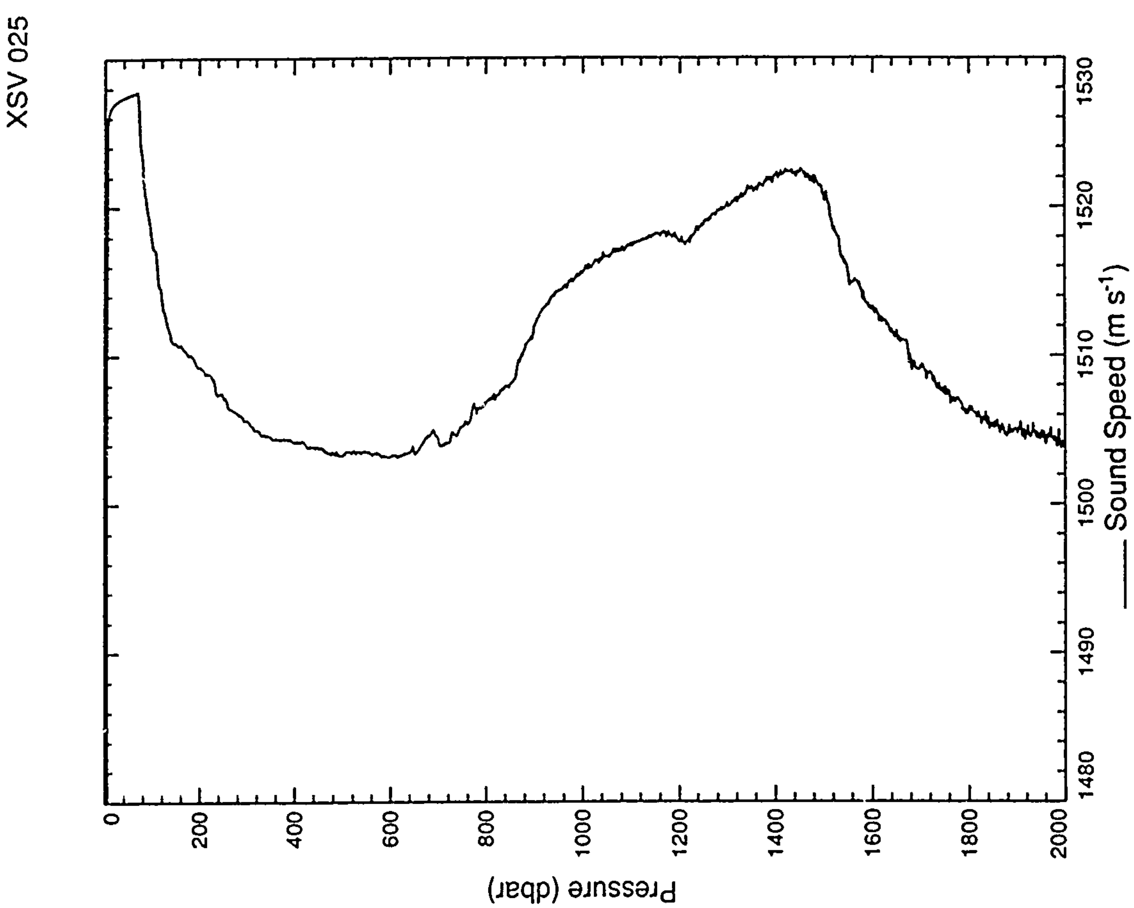
XSV 022

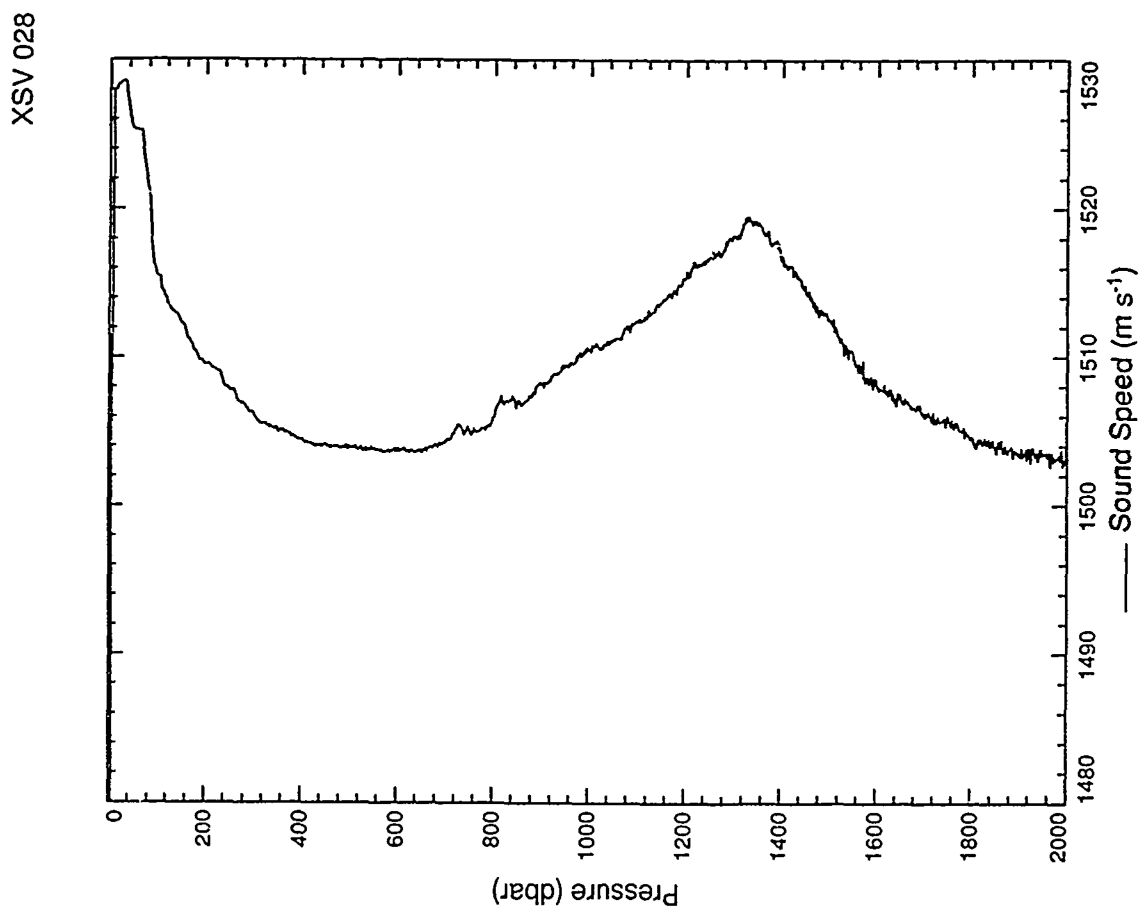


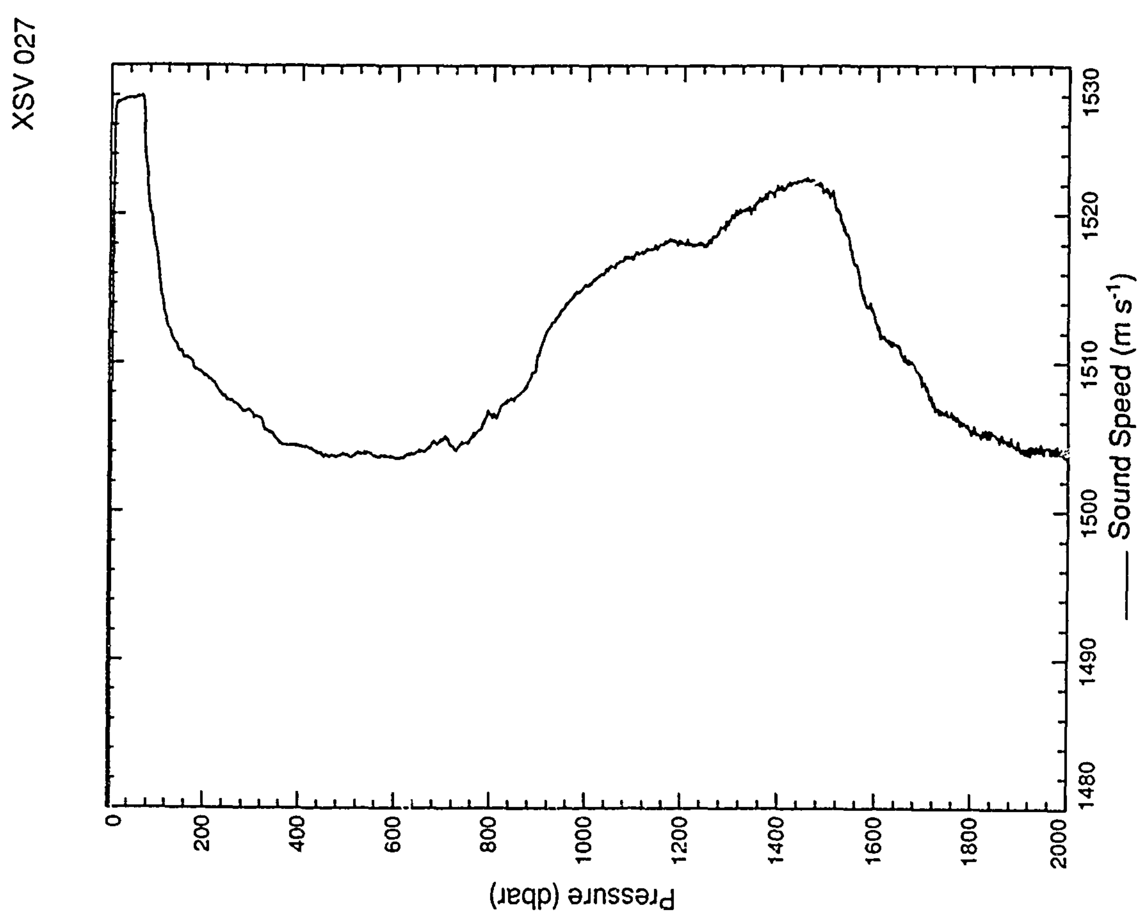

XSV 024
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530


XSV 023
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530

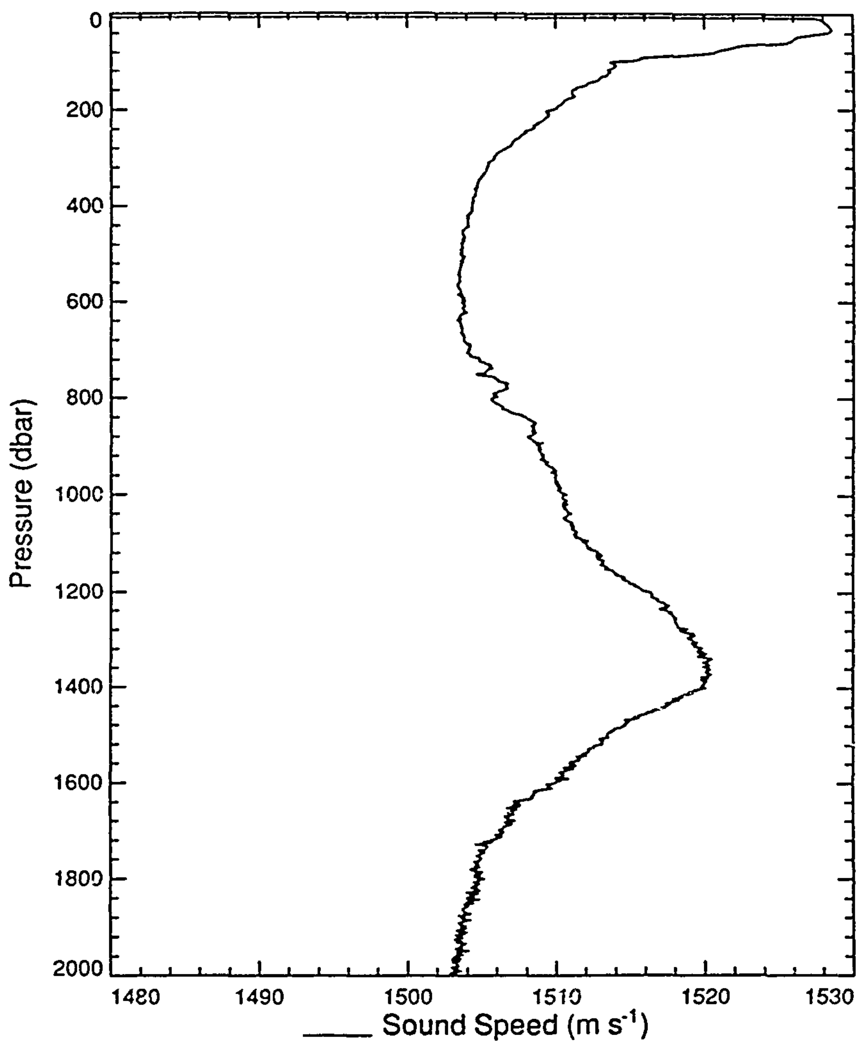

XSV 026
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530


XSV 025
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530

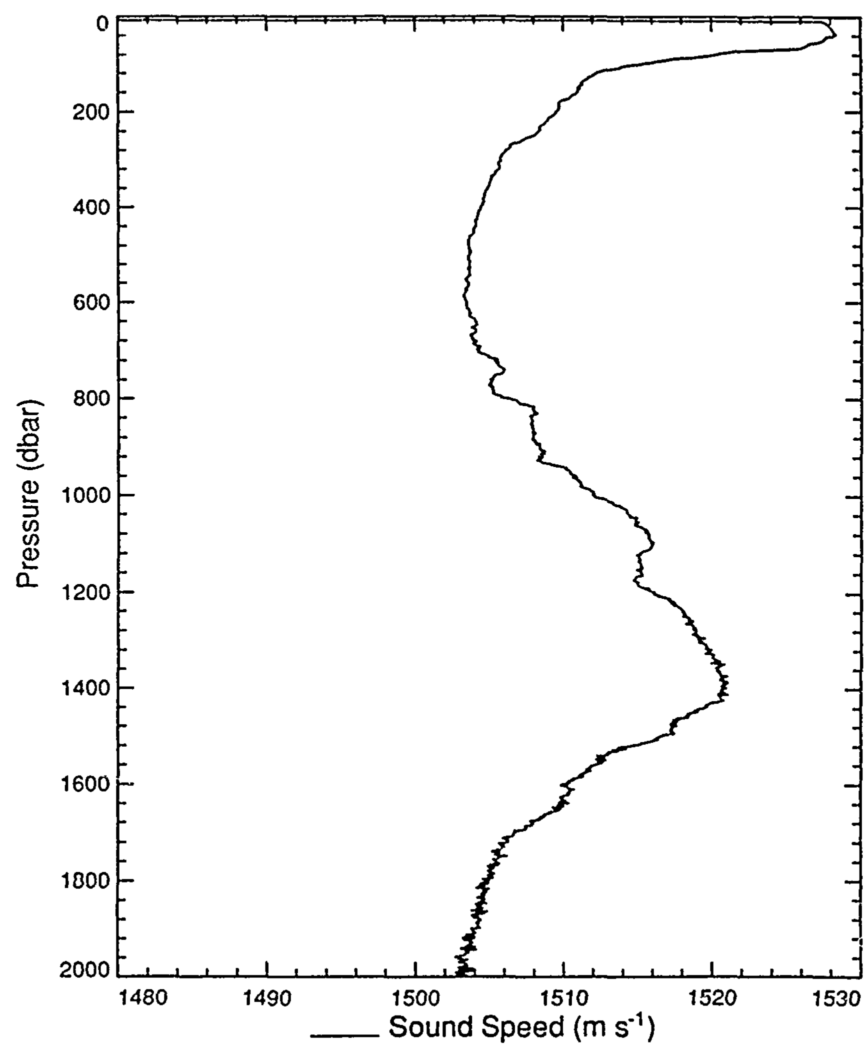

XSV 028
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530


XSV 027
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530

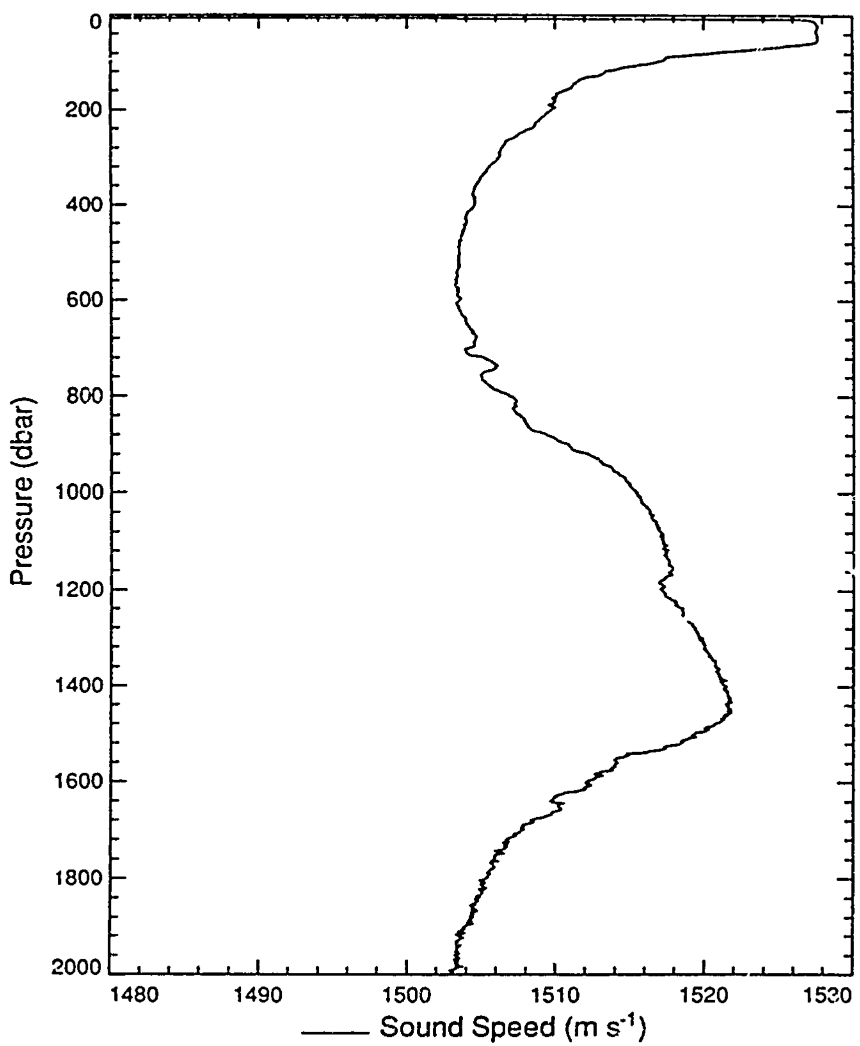
XSV 029



XSV 030

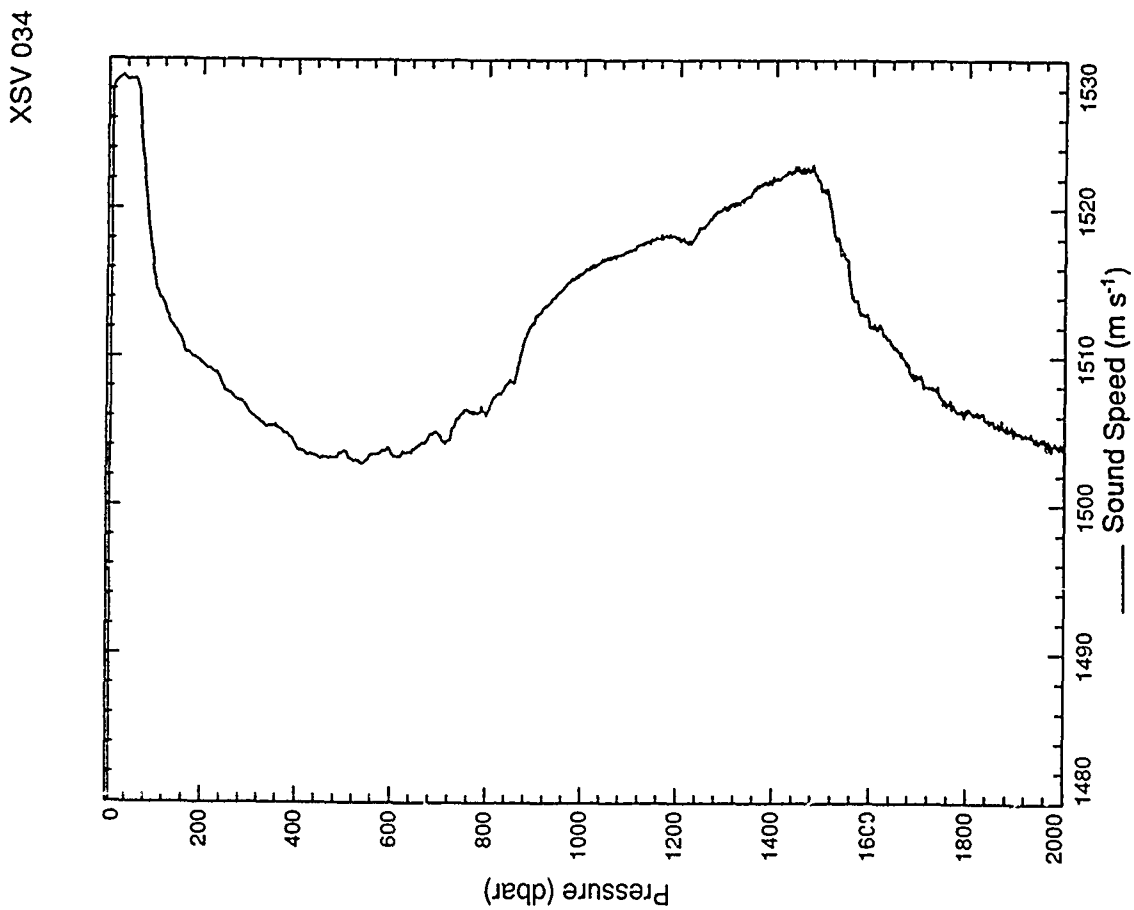


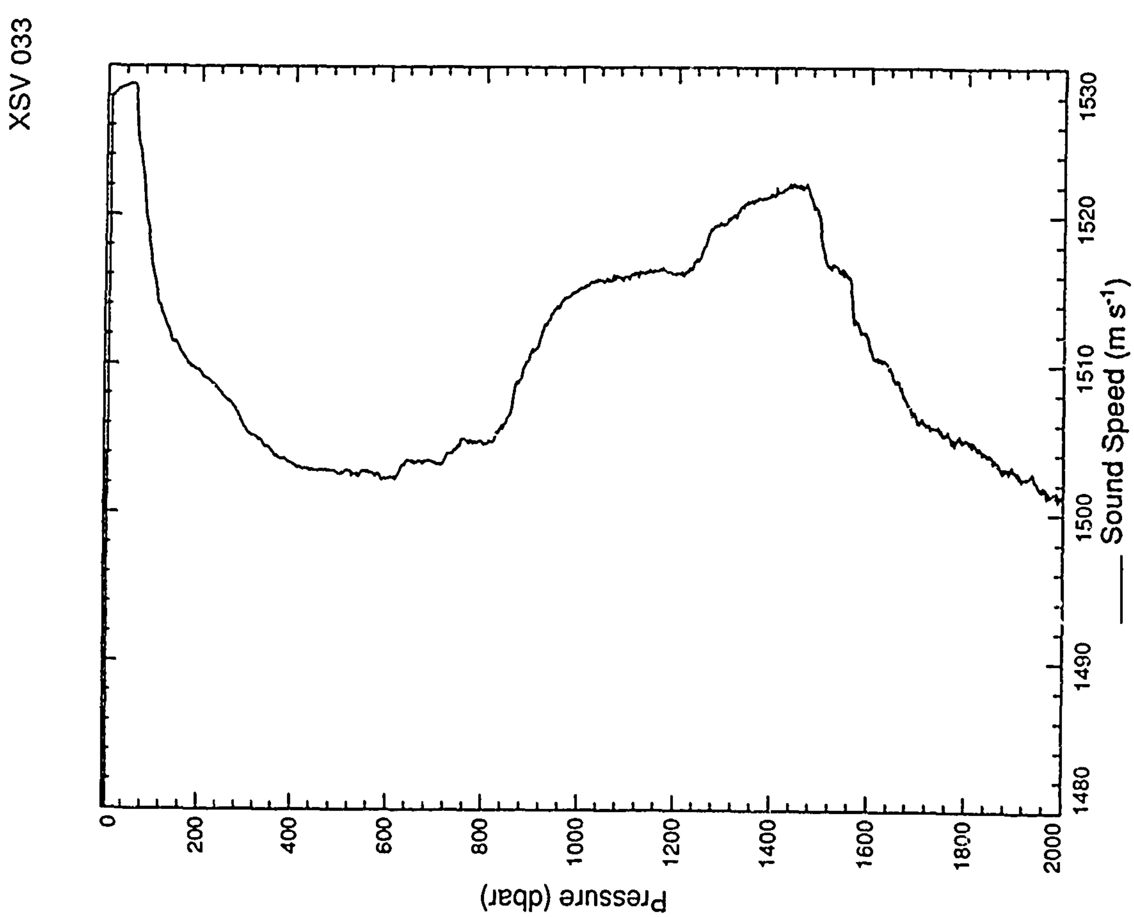
XSV 031



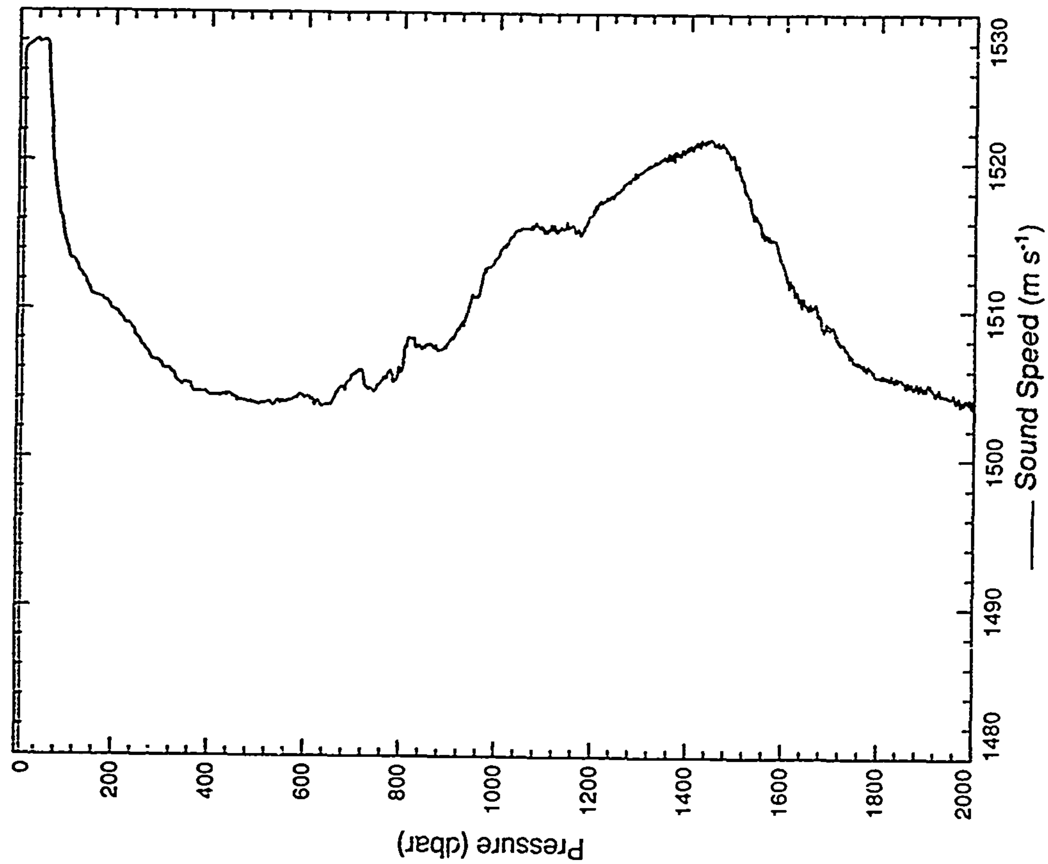
XSV 032

No Data

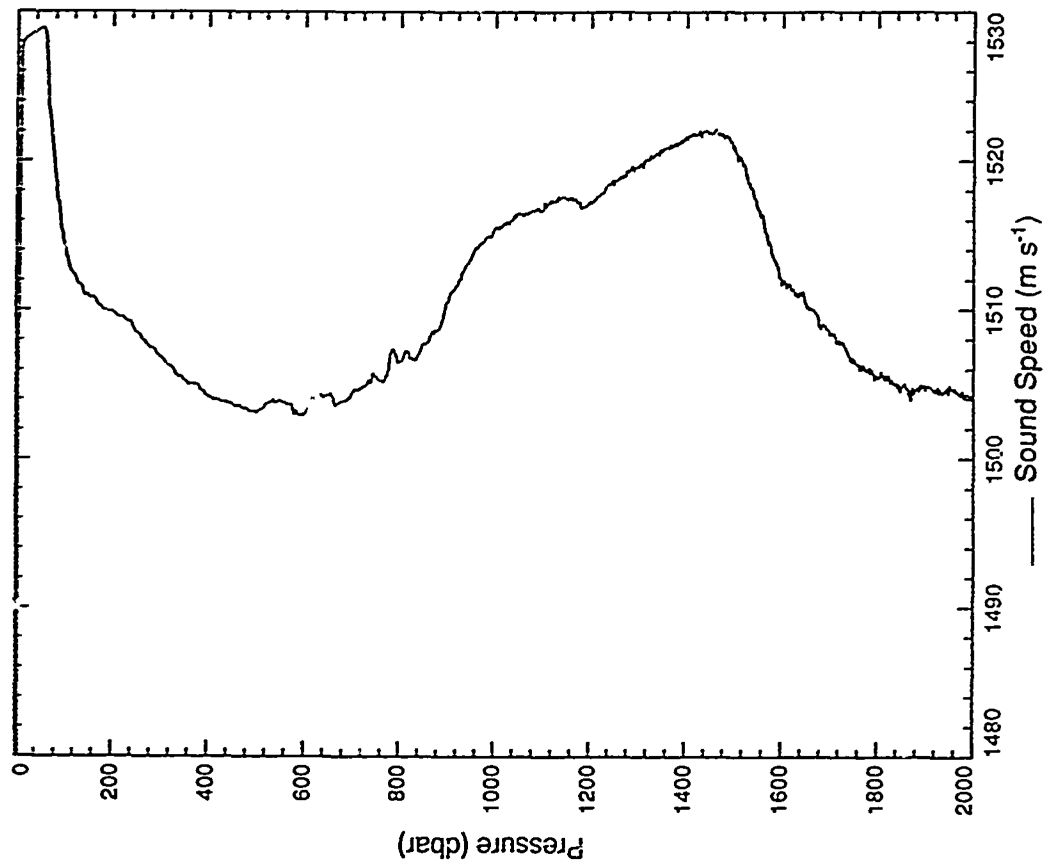

XSV 034
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

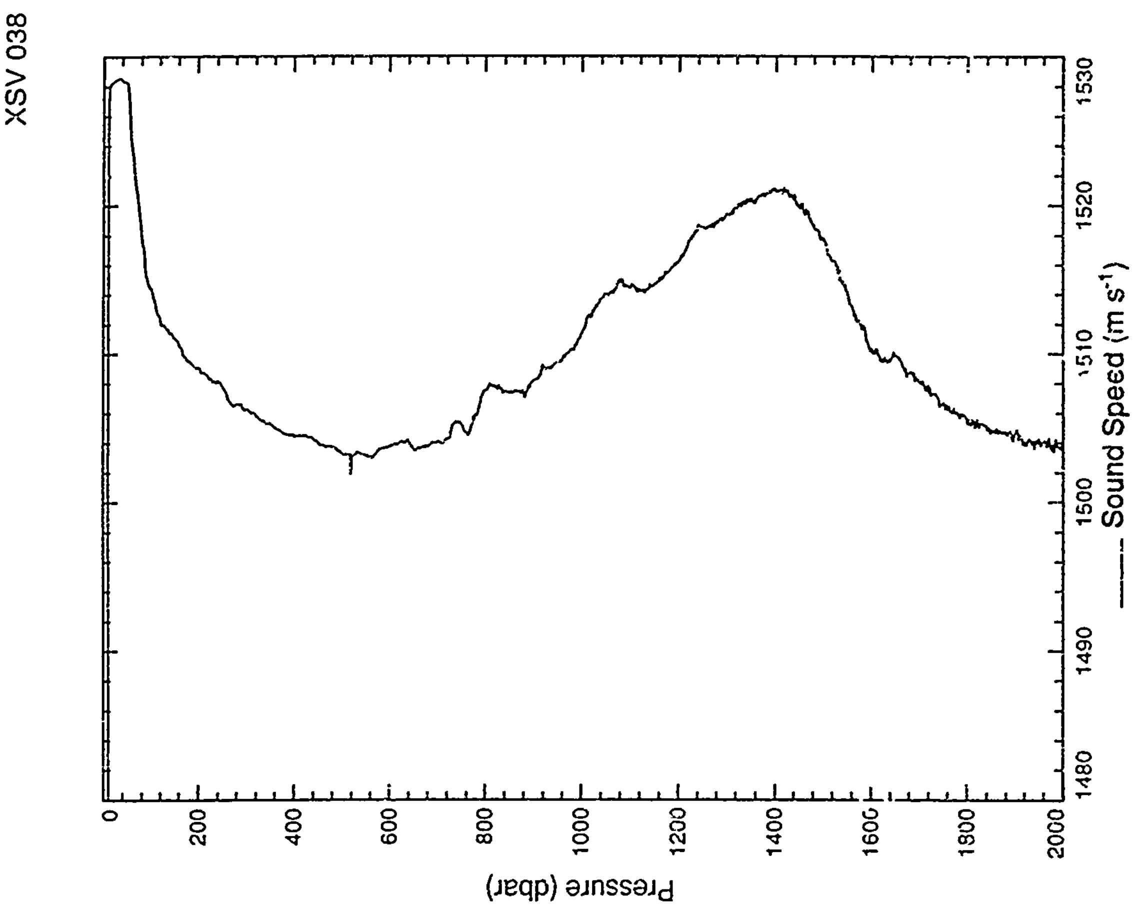

XSV 033
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

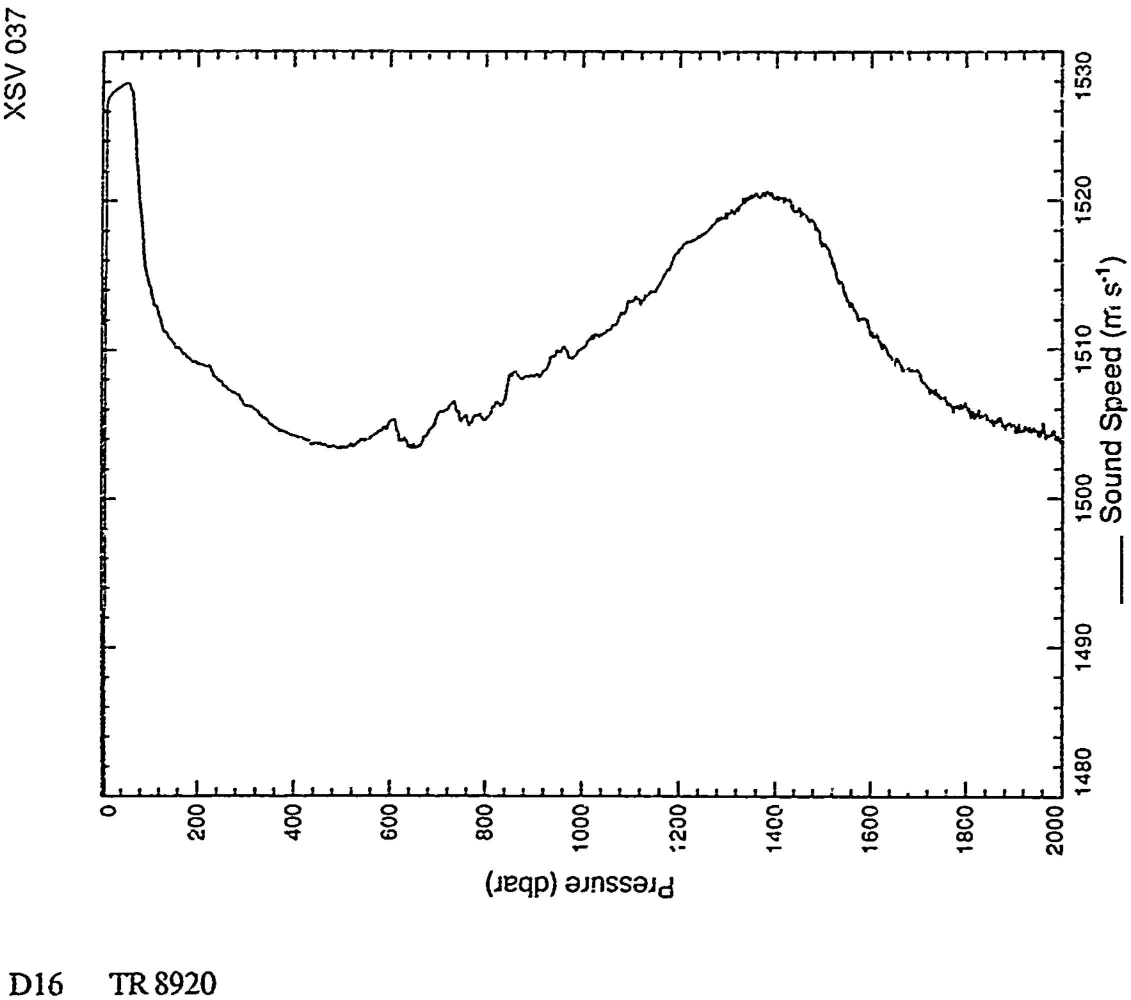
XSV 036



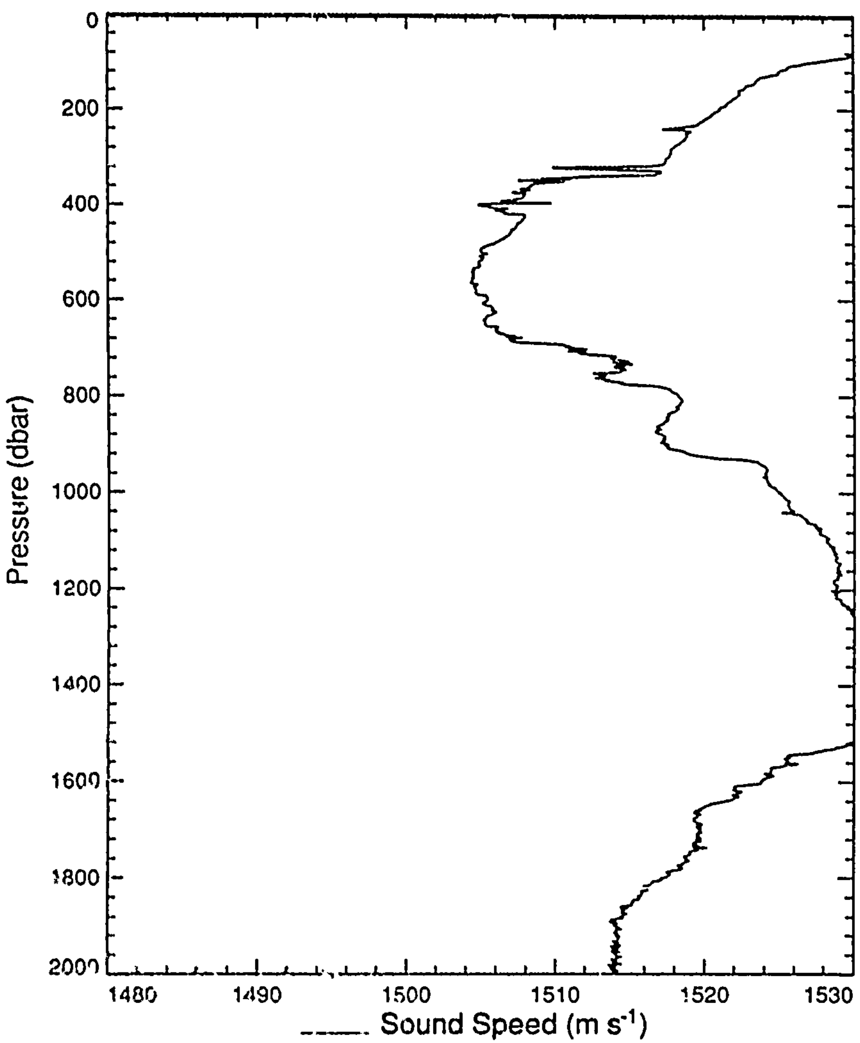
XSV 035



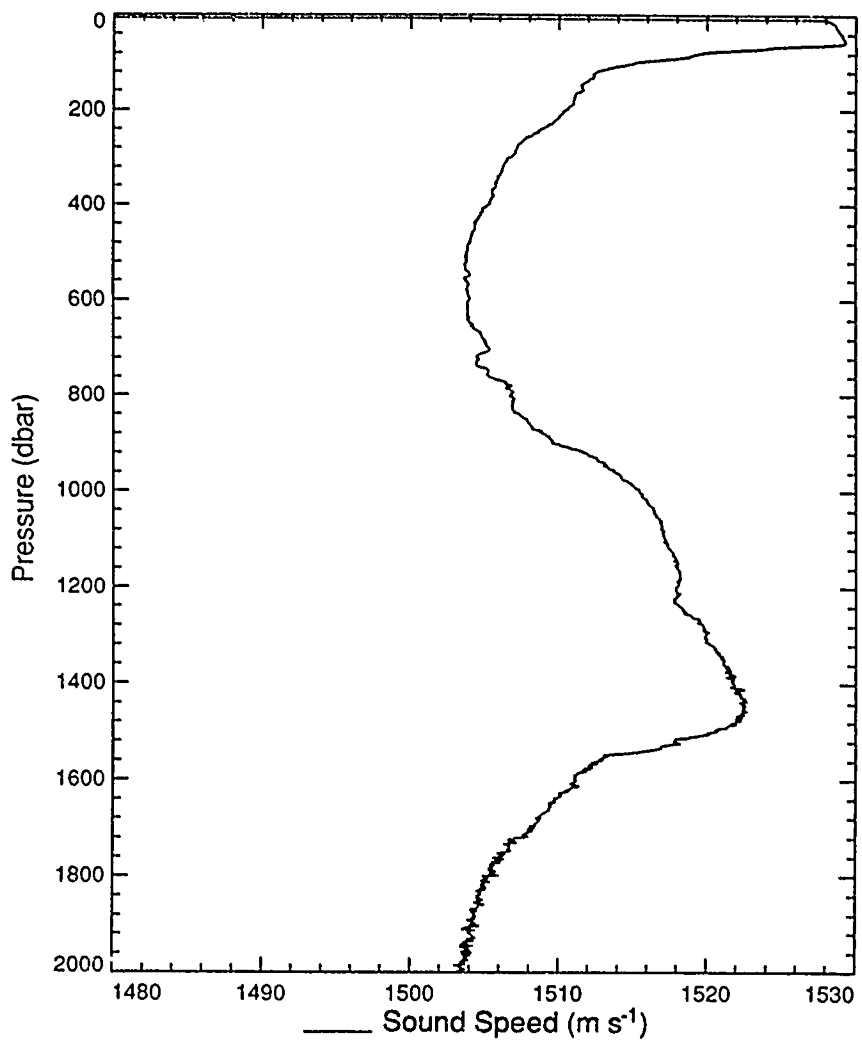

XSV 038
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

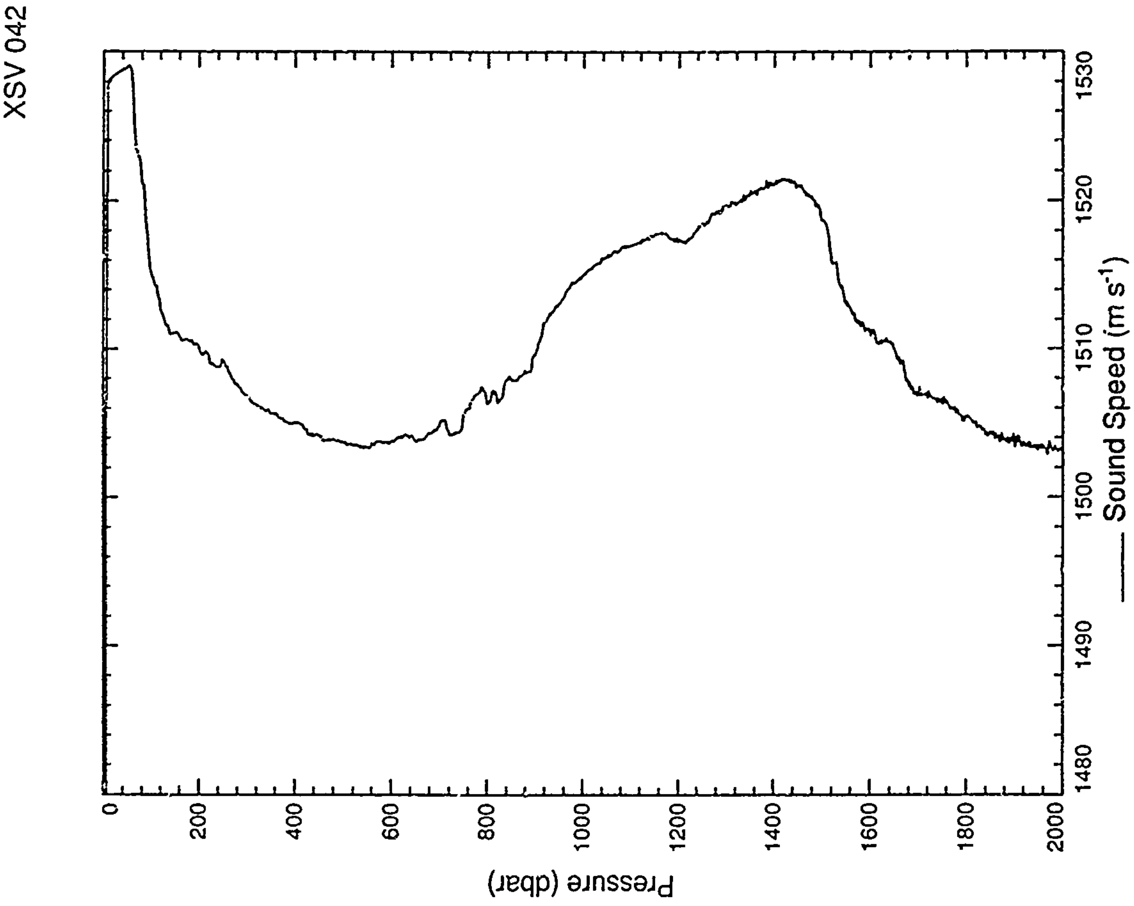

XSV 037
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

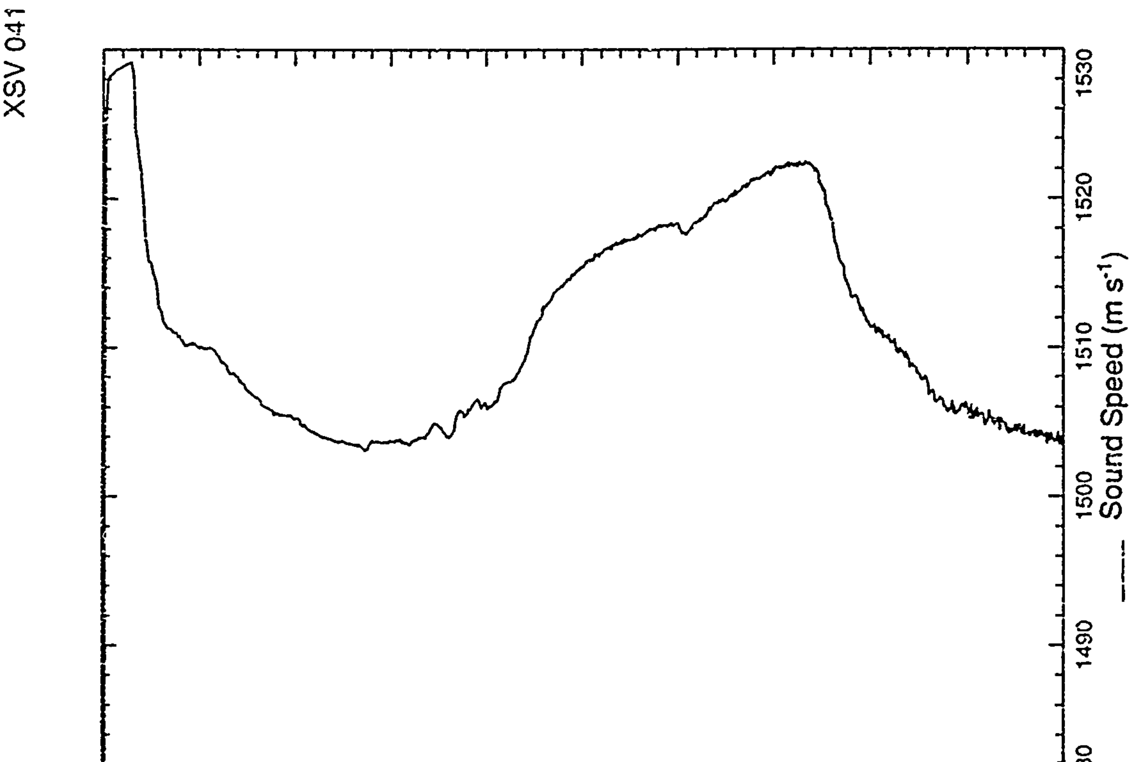
XSV 039



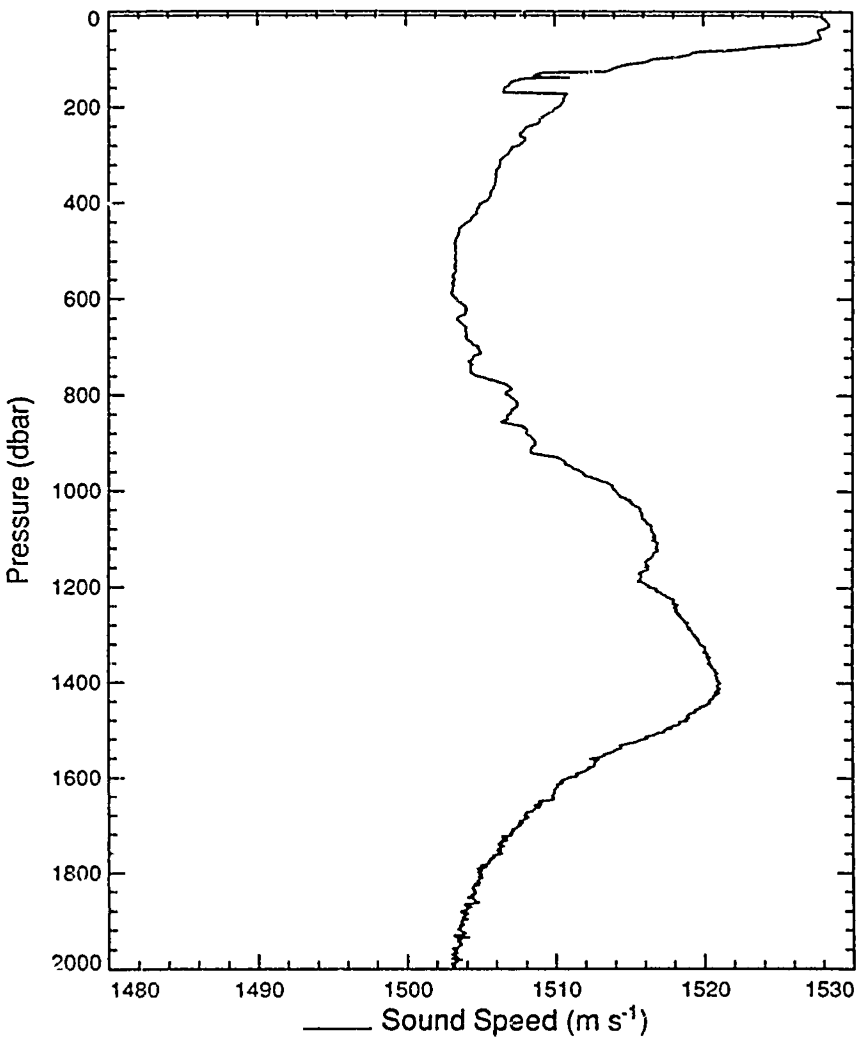
XSV 040



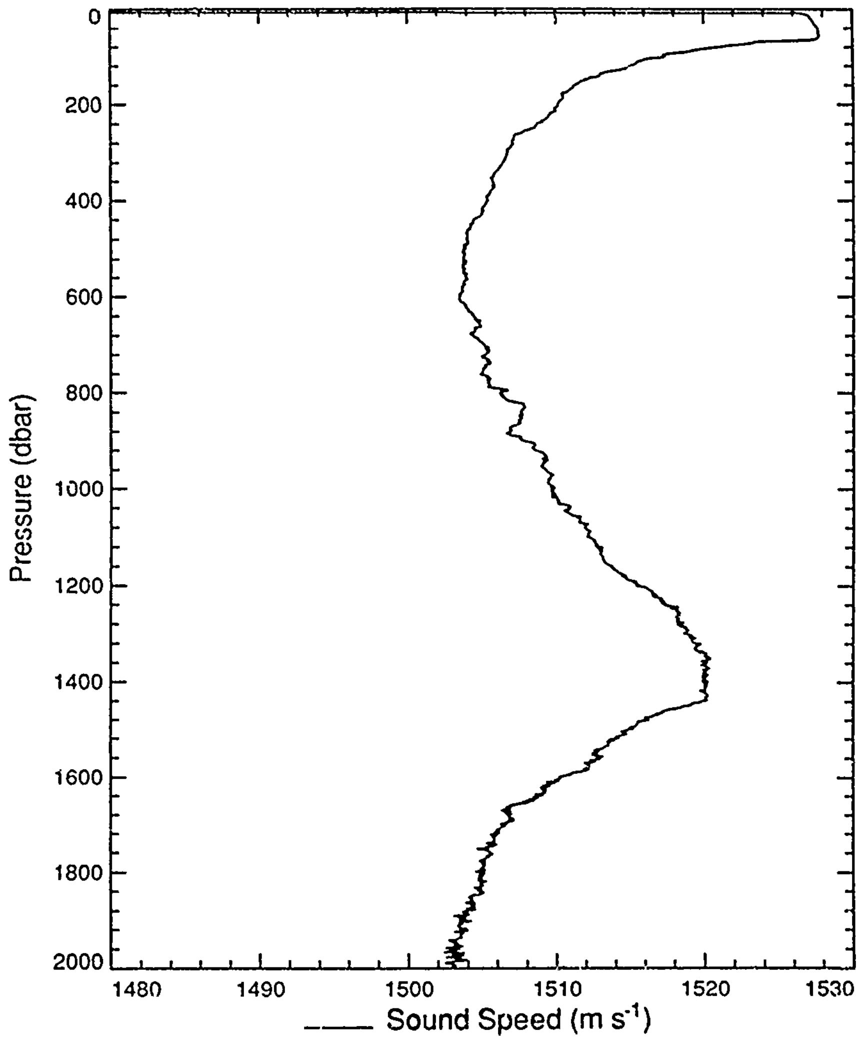

XSV 042
Pressure (dbar)
Sound Speed (m s-1)

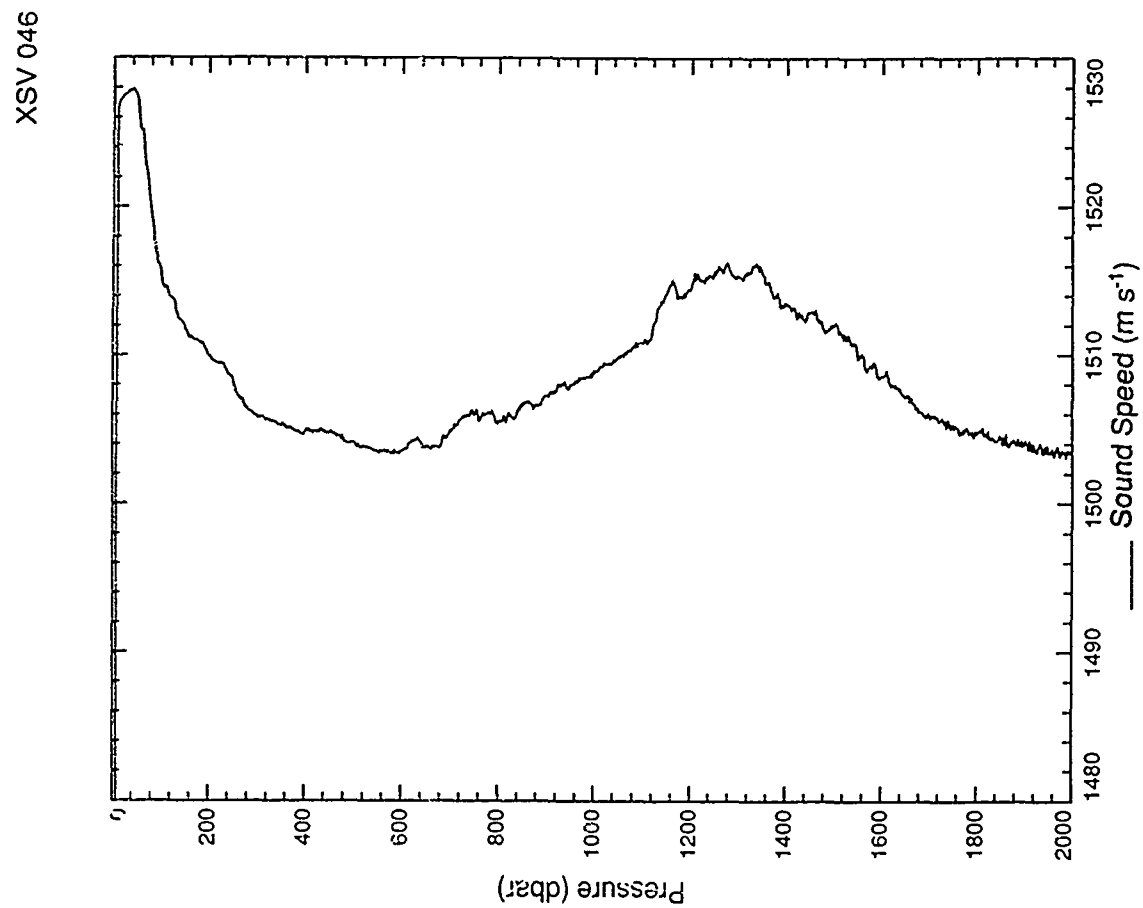

XSV 041
Pressure (dbar)
Sound Speed (m s-1)

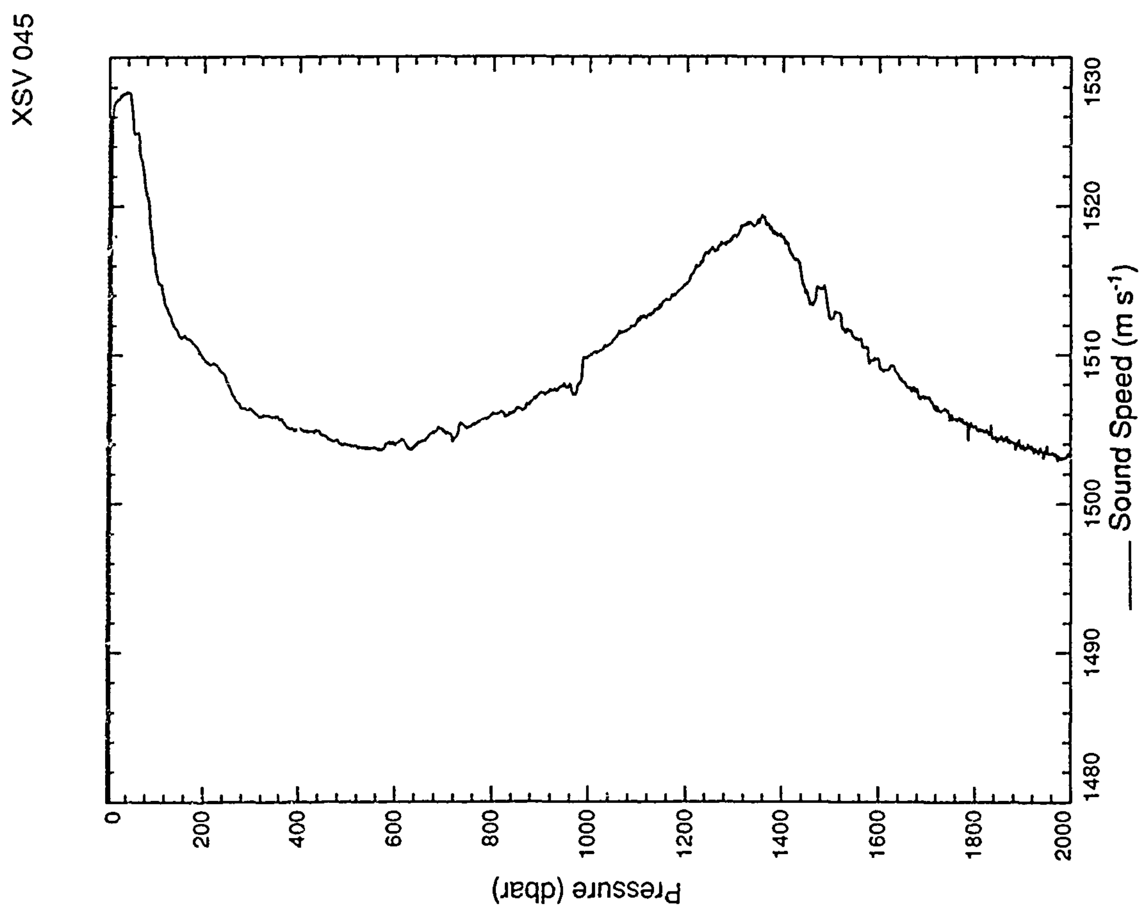
XSV 043

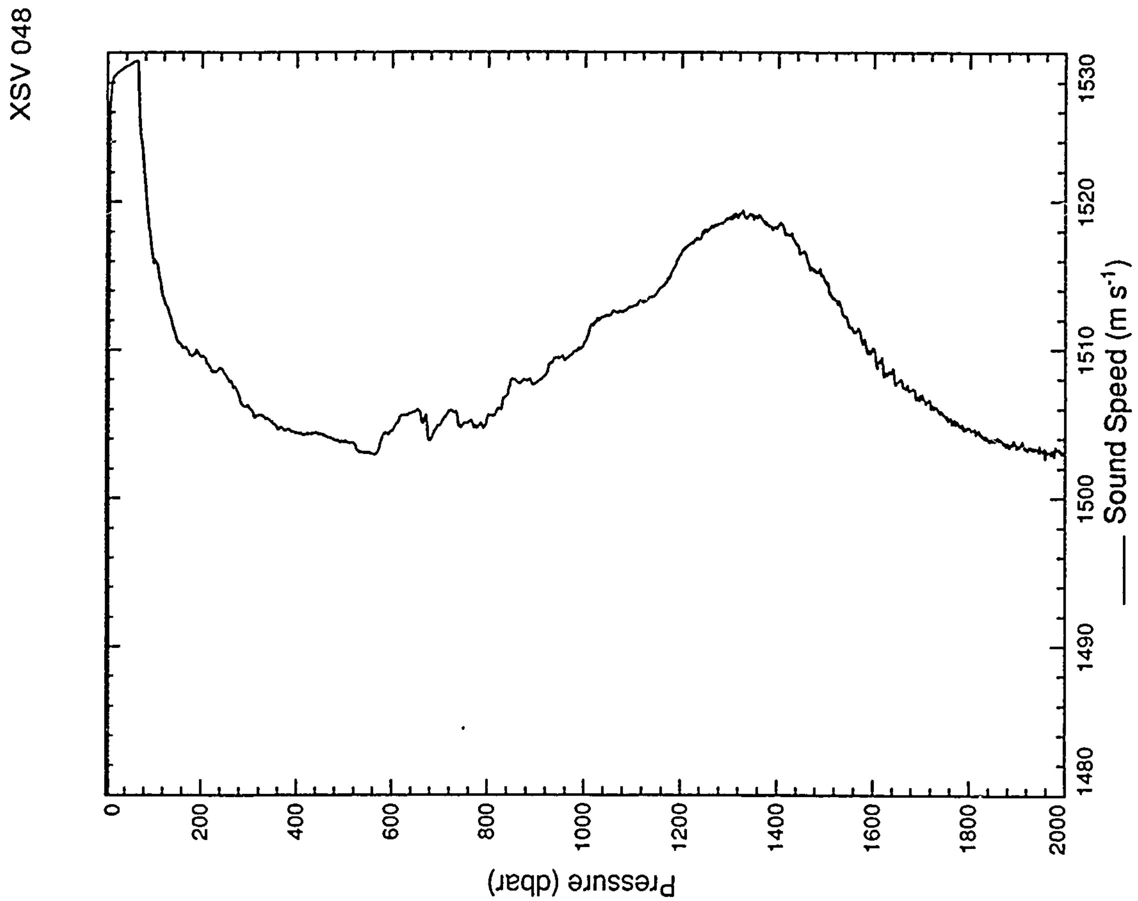


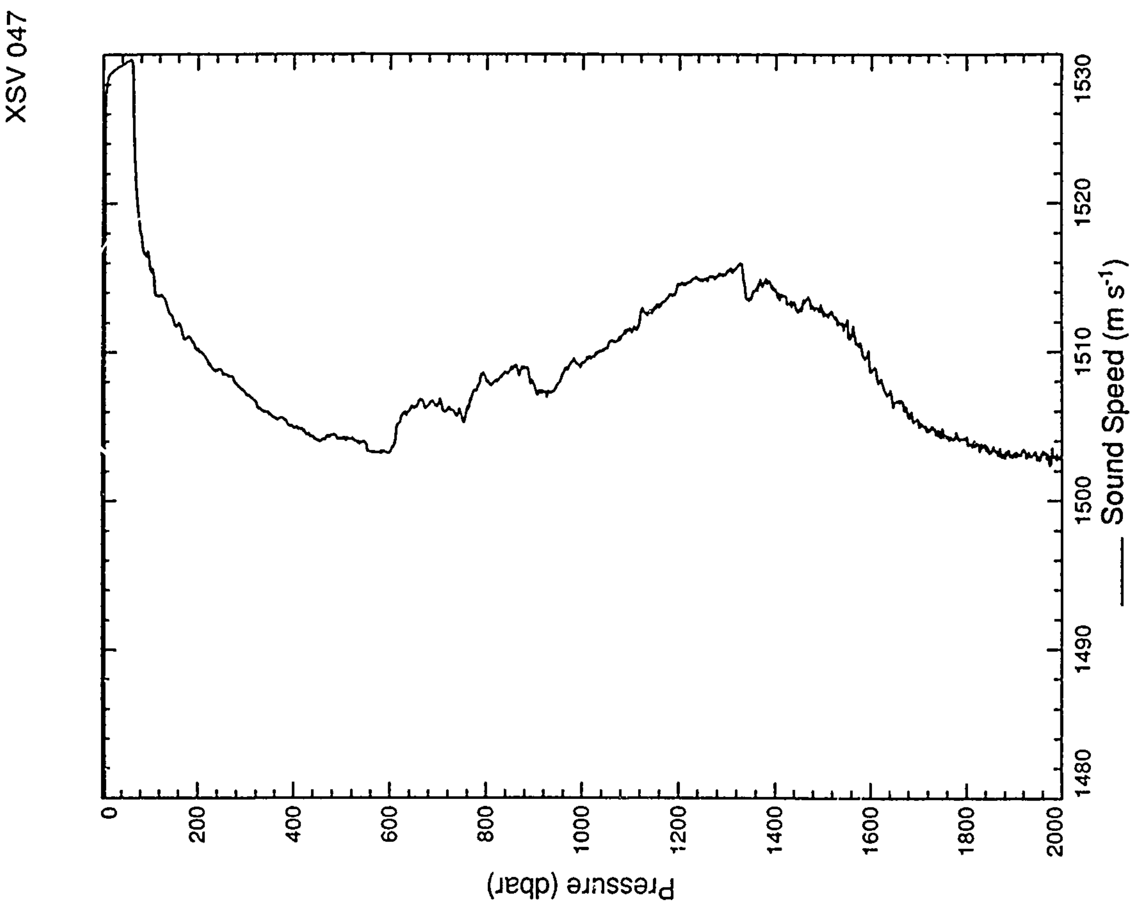
XSV 044



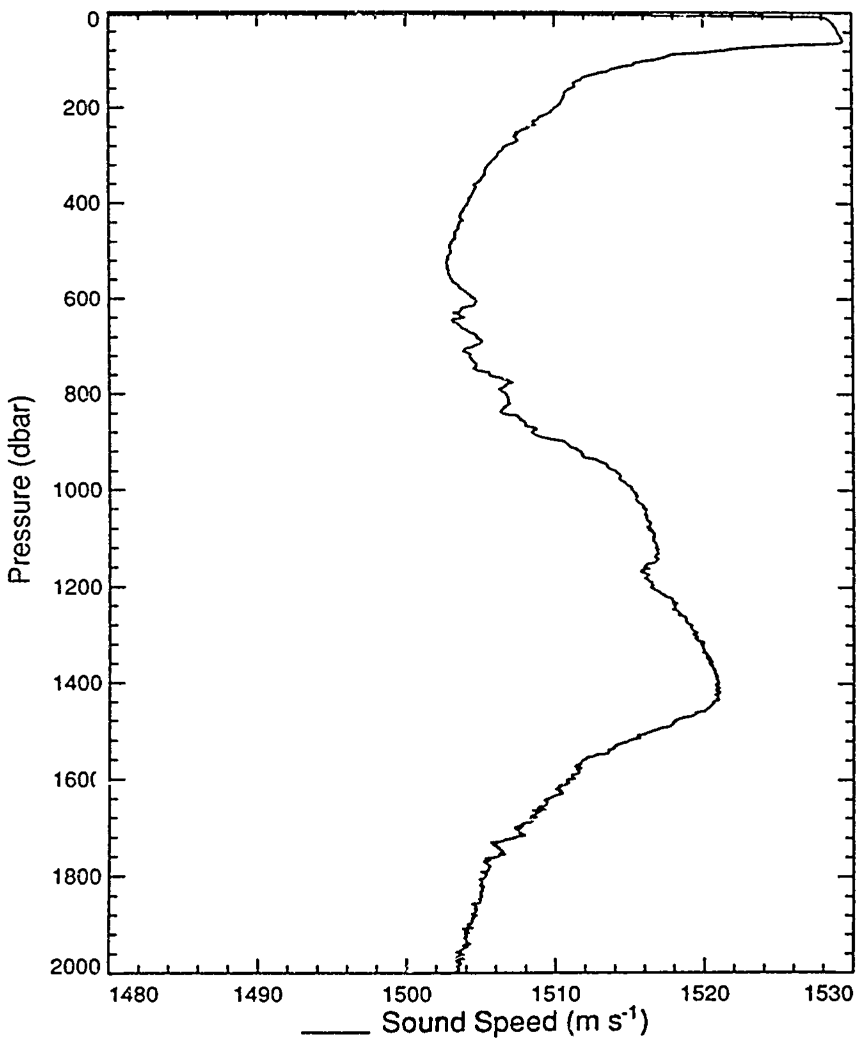

XSV 046
Pressure (dbar)
Sound Speed (m s-1)
200 400 600 800 1000 1200 1400 1600 1800 2000
1480 1490 1500 1510 1520 1530


XSV 045
Pressure (dbar)
Sound Speed (m s-1)
0 200 400 600 800 1000 1200 1400 1600 1800 2000
1480 1490 1500 1510 1520 1530

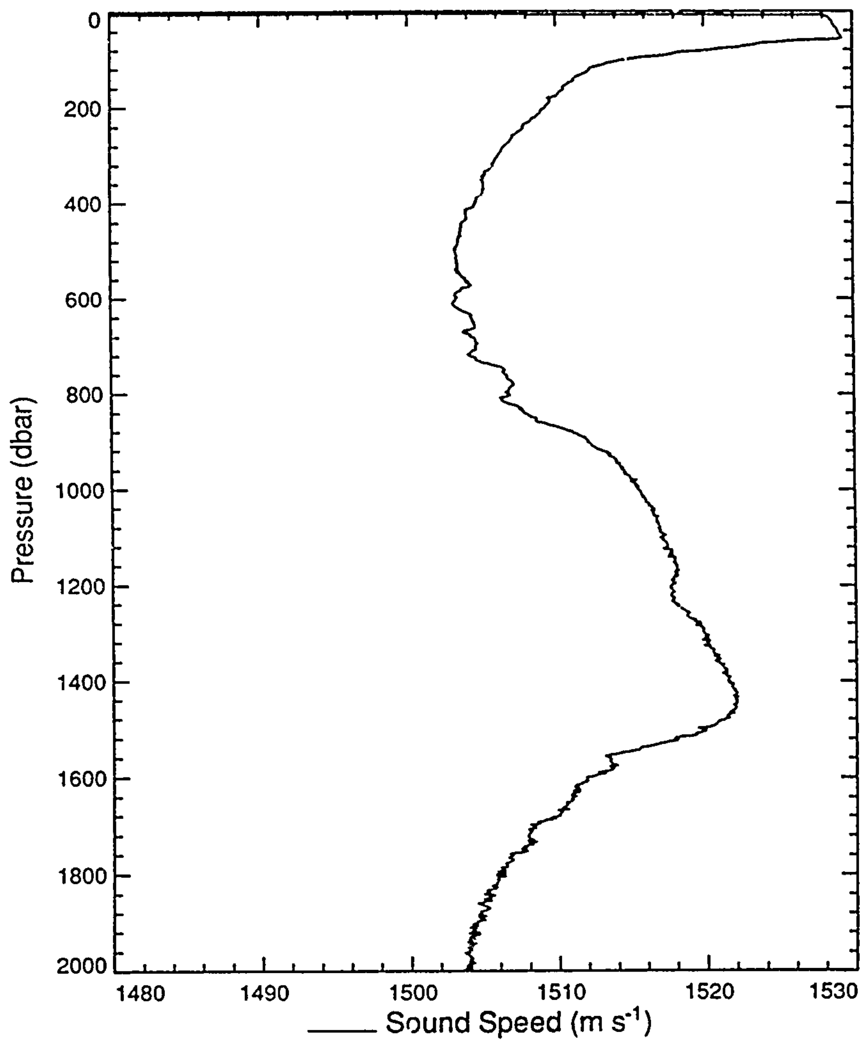

XSV 048
Pressure (dbar)
Sound Speed (m s-1)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530

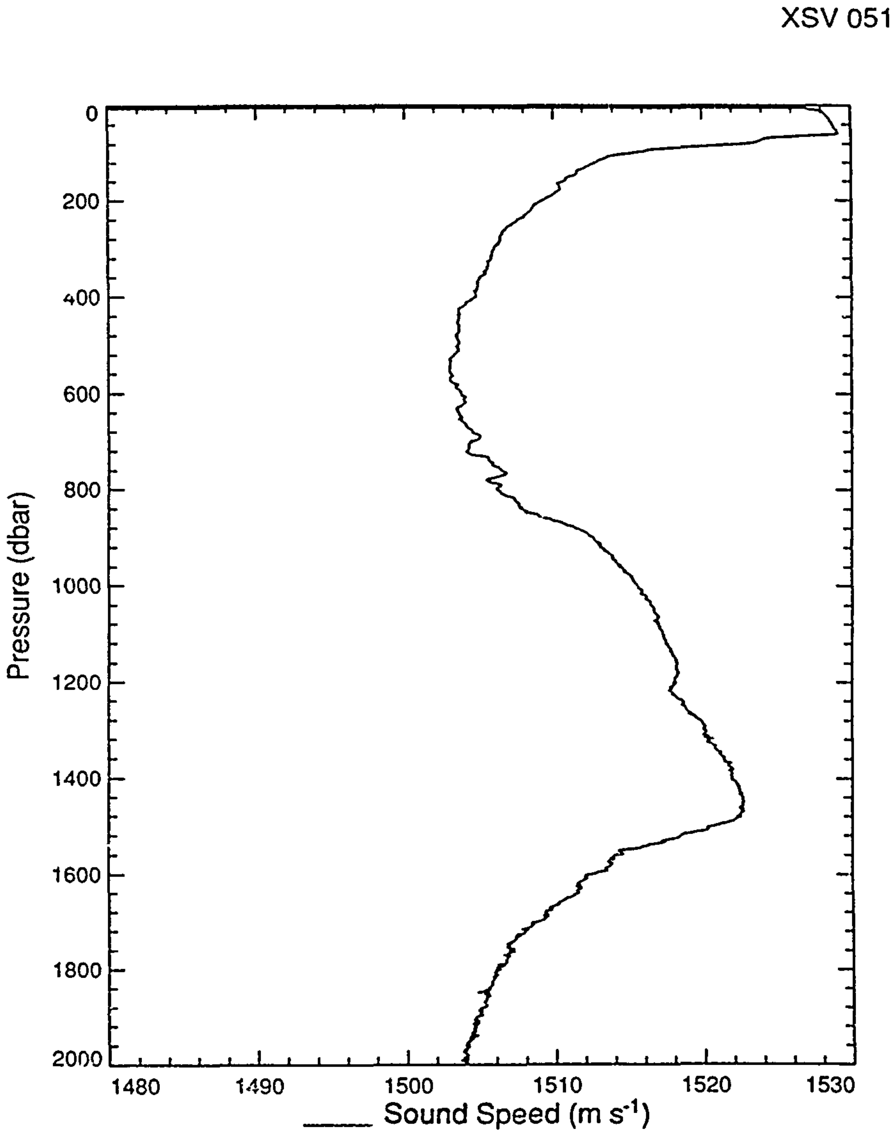

XSV 047
Pressure (dbar)
Sound Speed (m s-1)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530

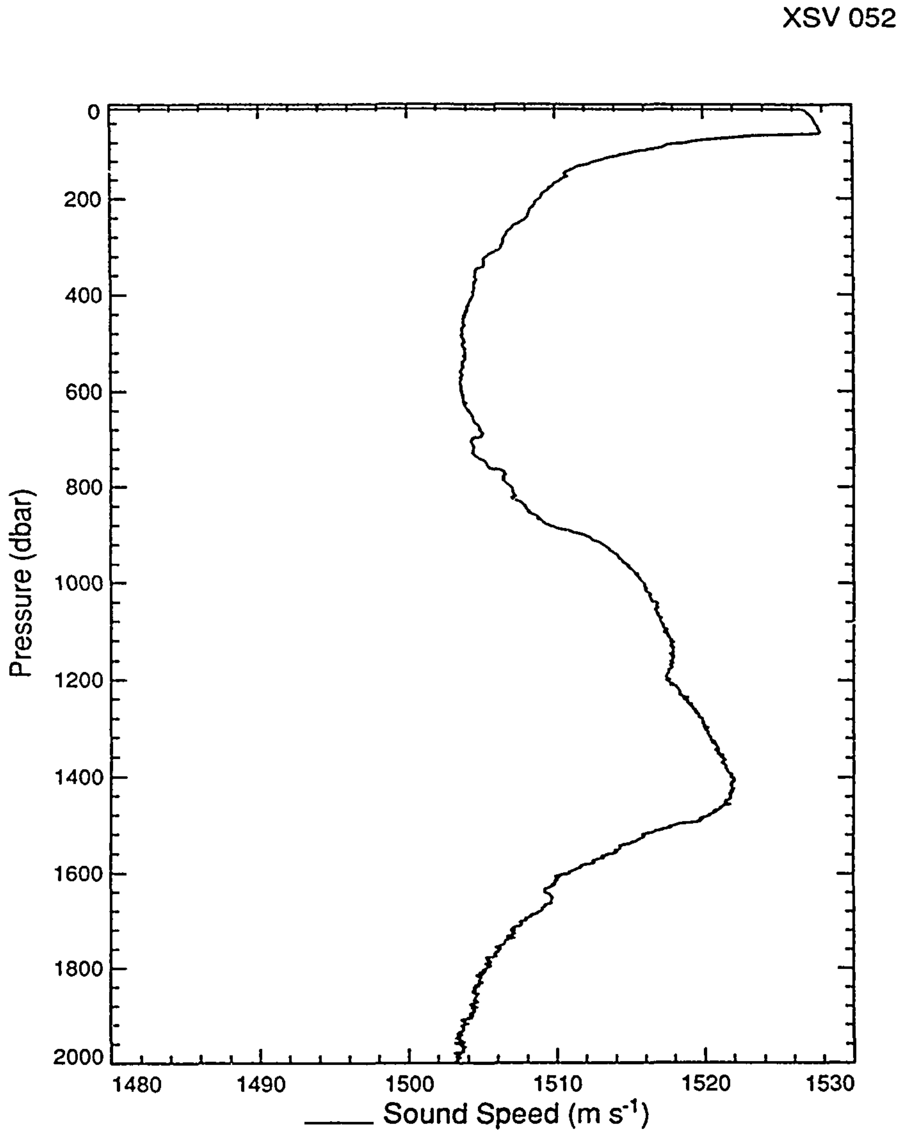
XSV 049



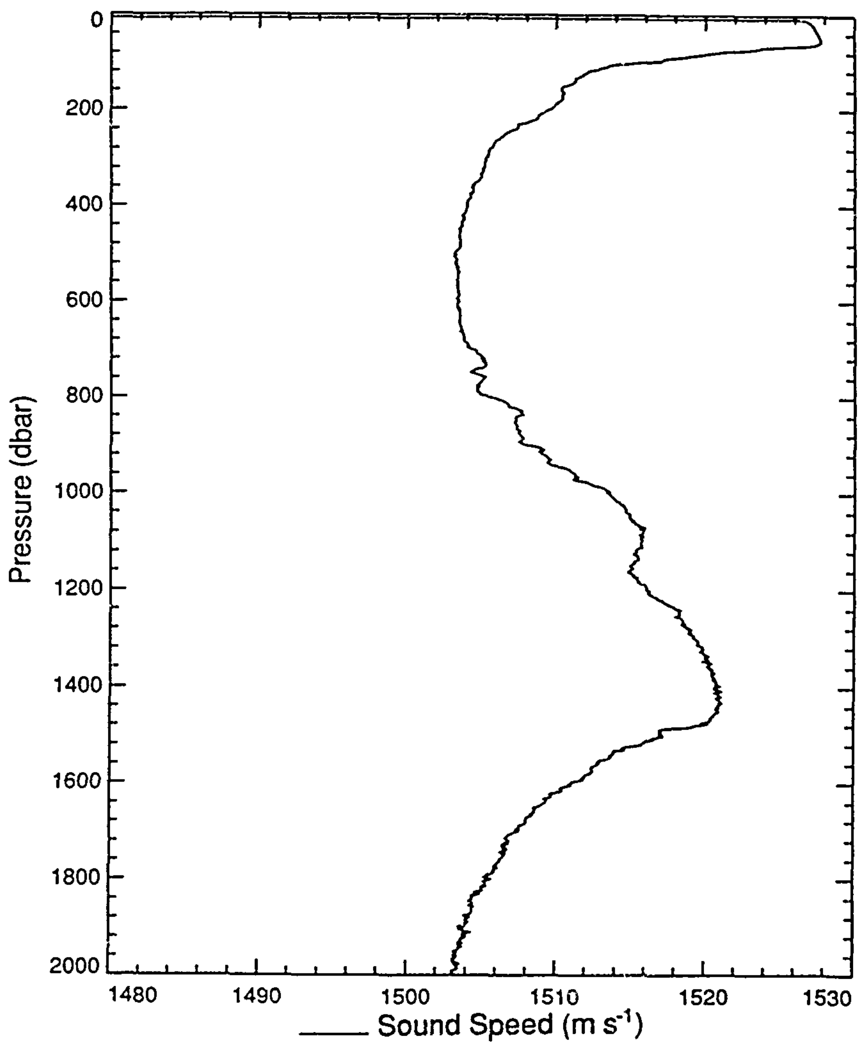
XSV 050



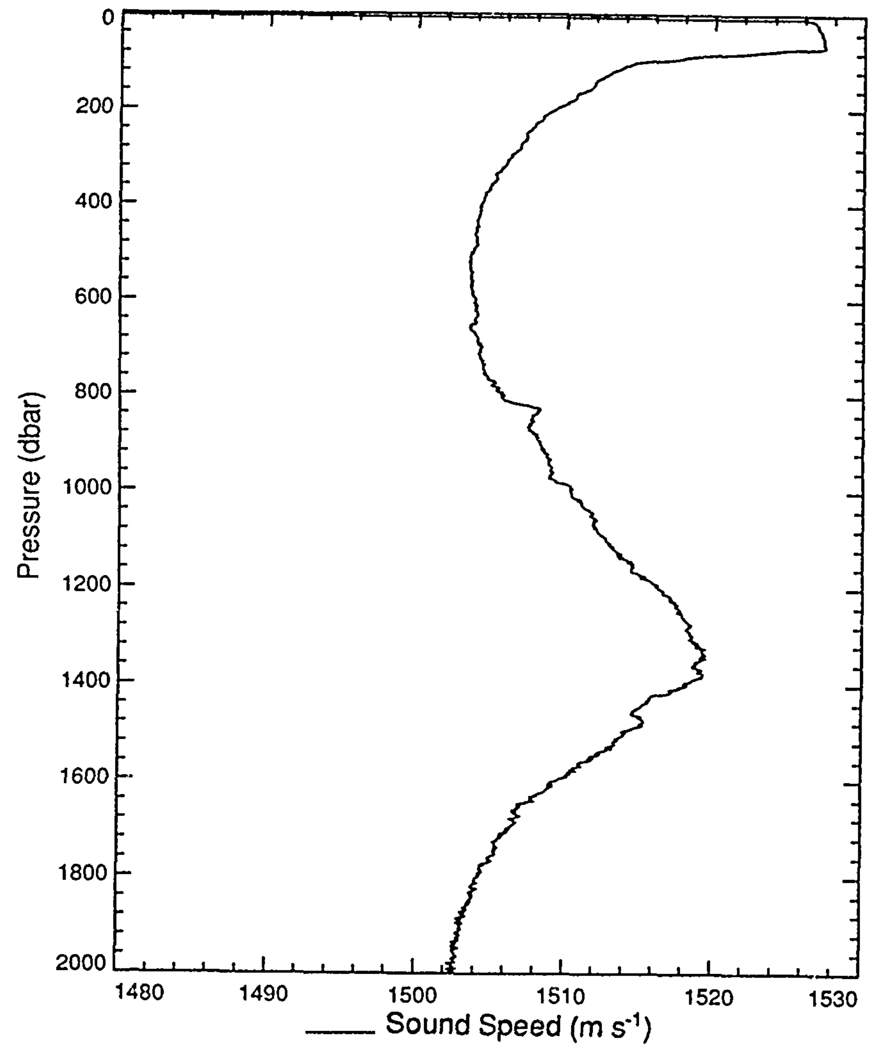

XSV 051
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

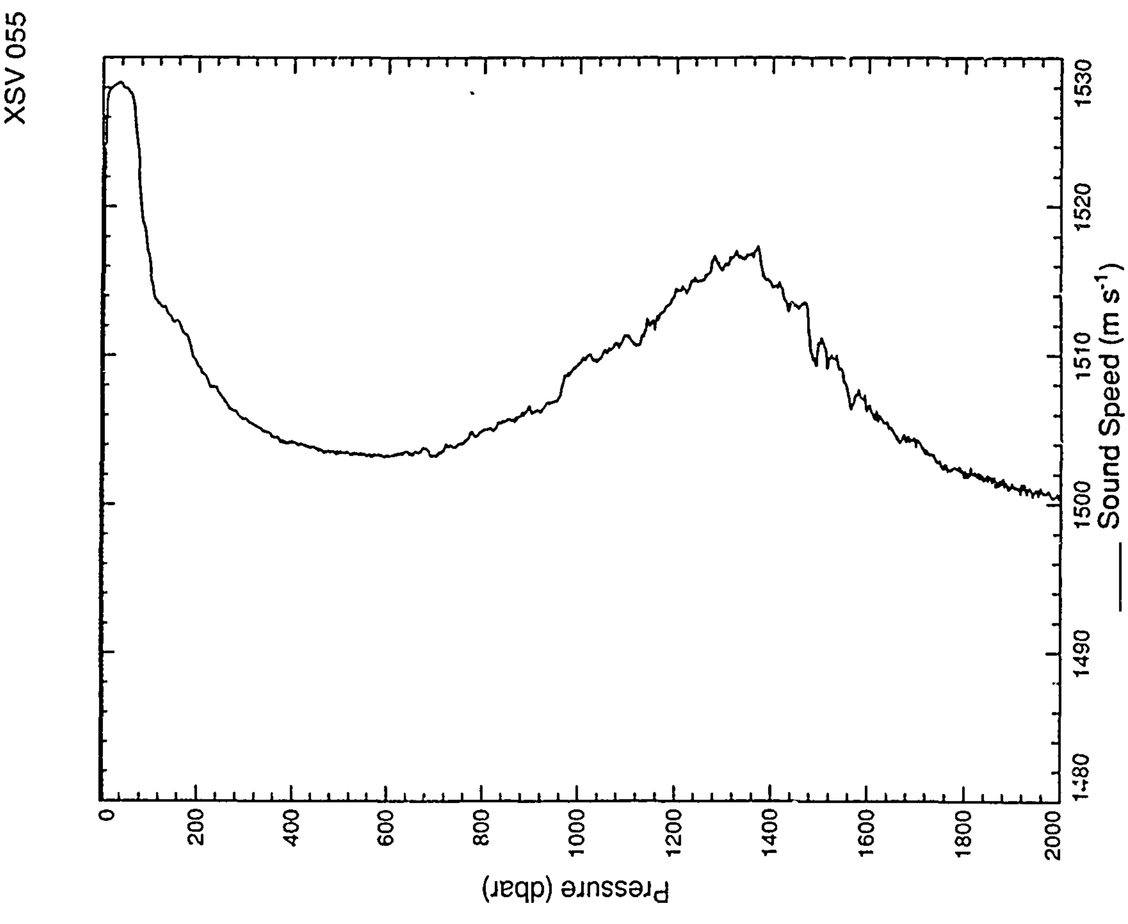

XSV 052
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1480
1490
1500
1510
1520
1530
Sound Speed (m s-1)

XSV 053



XSV 054

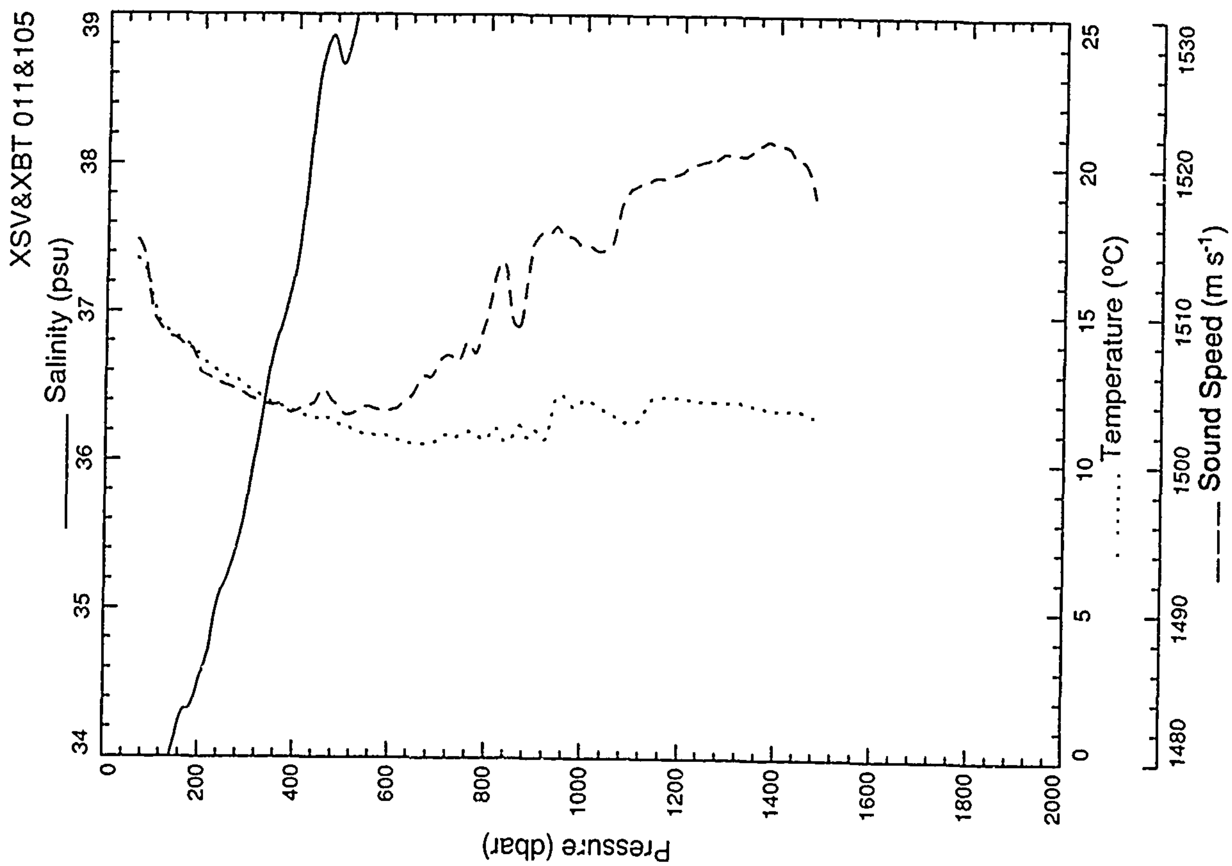


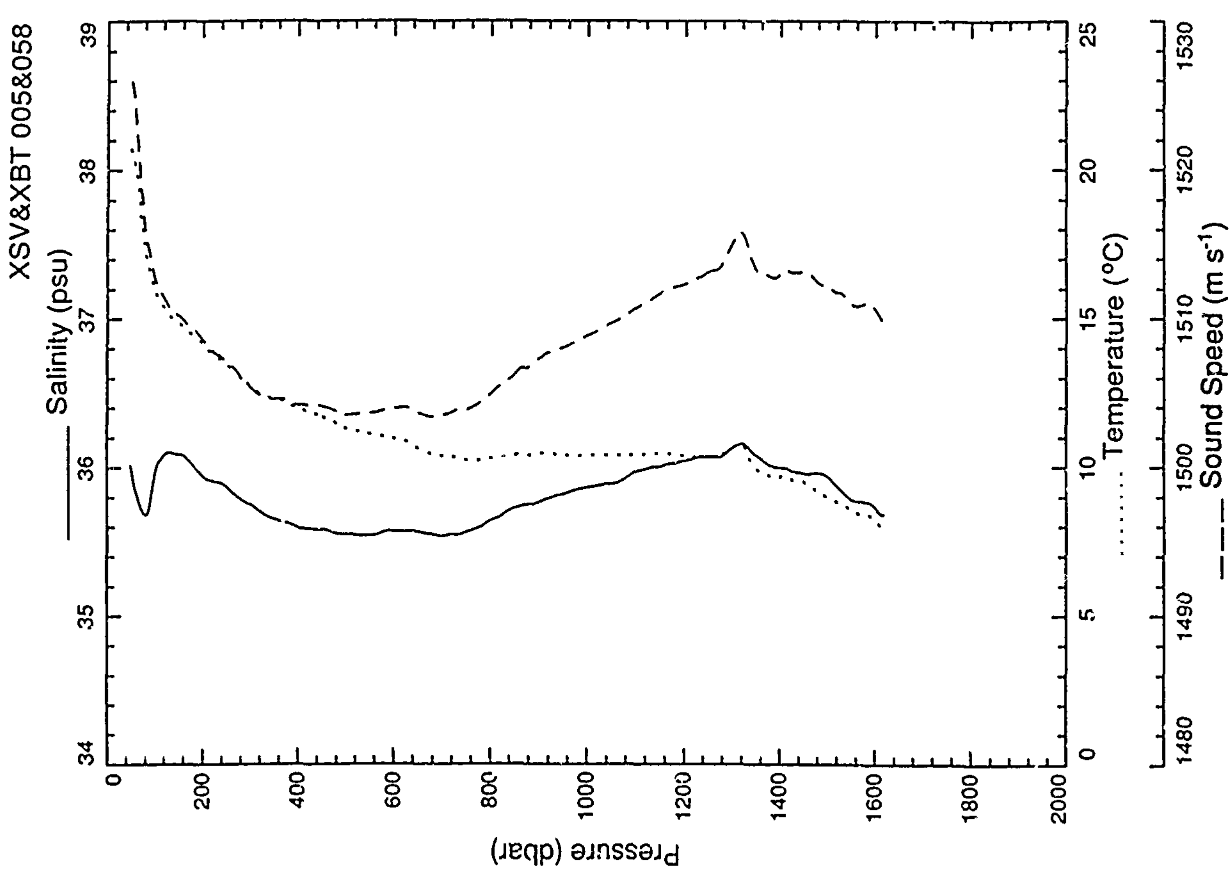

XSV 055
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530

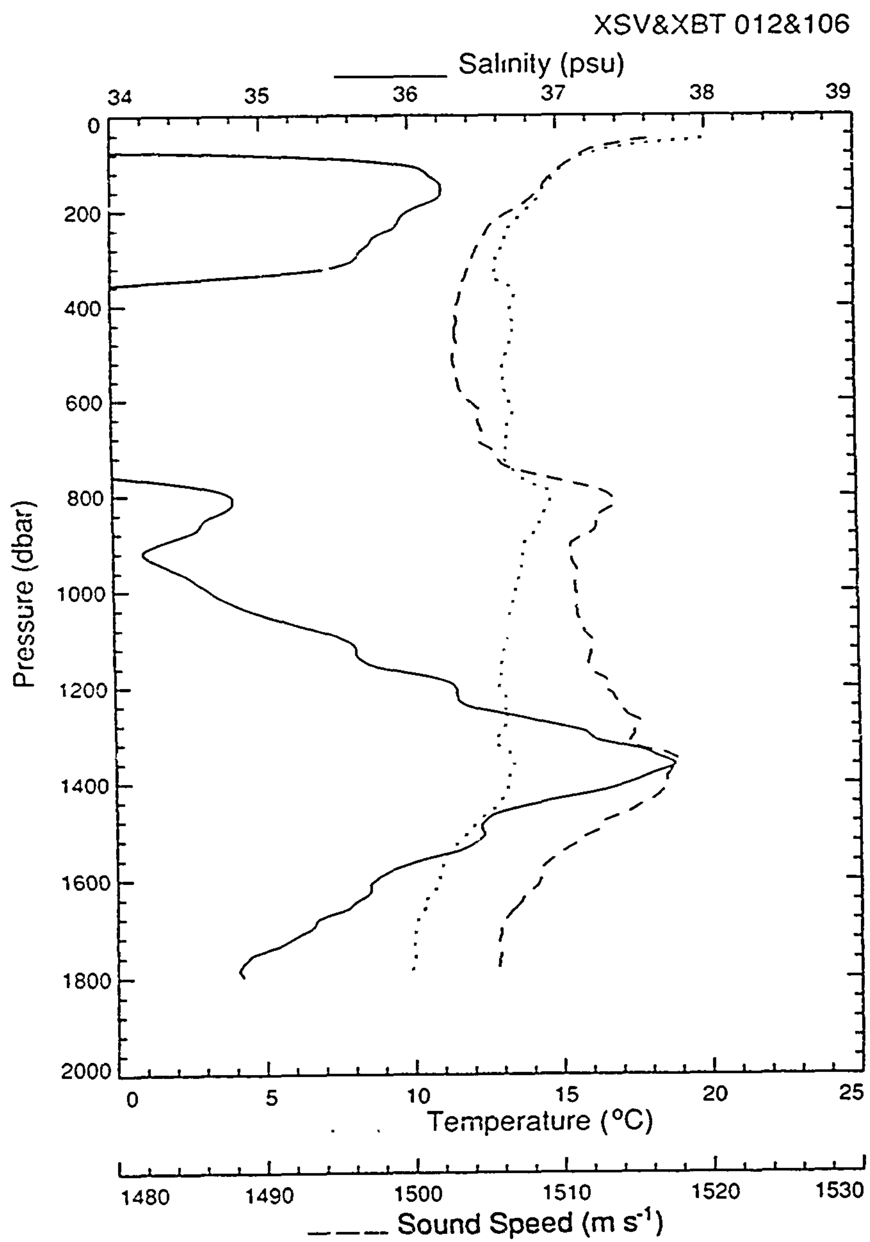
APPENDIX E

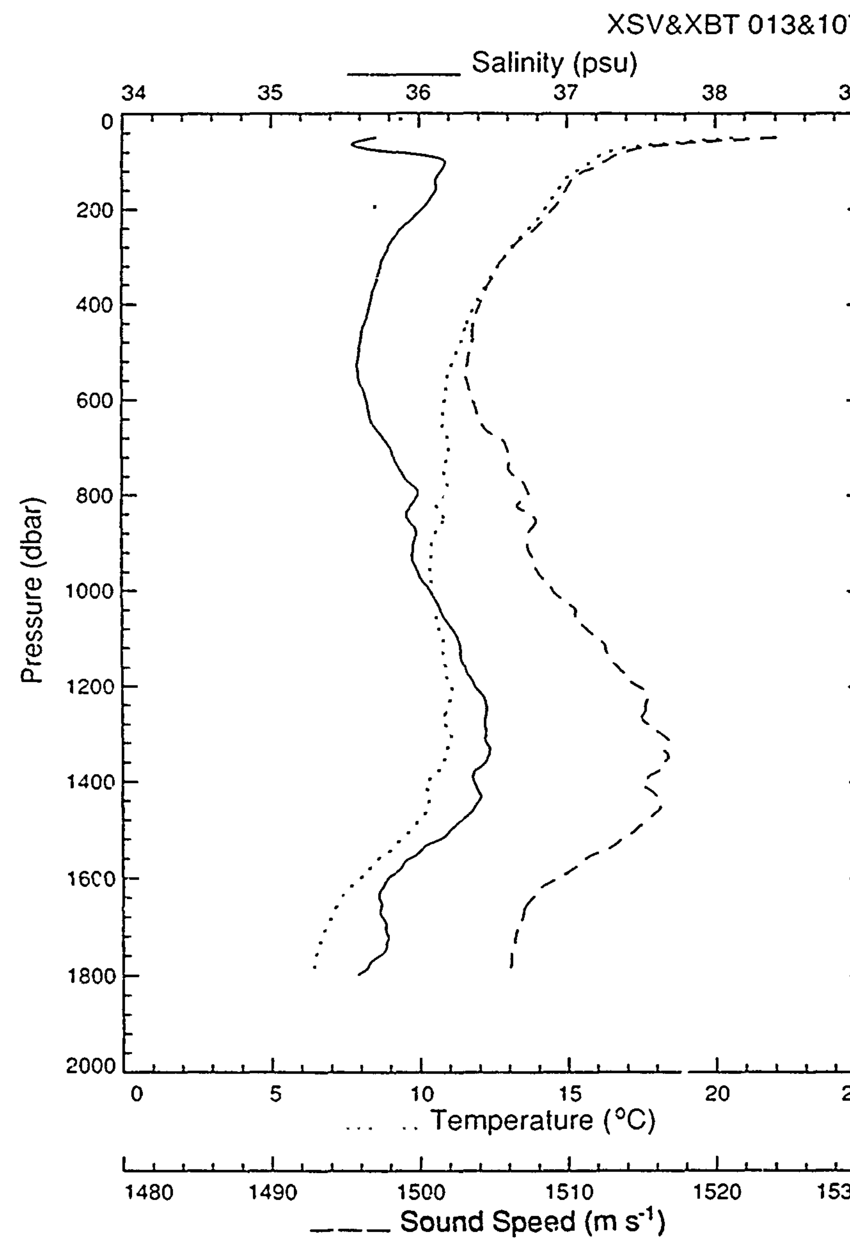
Profiles of Temperature, Sound Speed, and Computed Salinity for All Good Drop Pairs

The XSV probe depths were corrected individually, using the data from simultaneously dropped XBT probes as described in Section 5.1. The data have been gridded into 2 dbar bins. Salinity is averaged over 50 dbar; temperature and sound speed are averaged over 20 dbar. Salinity was determined as described in Section 5.4.

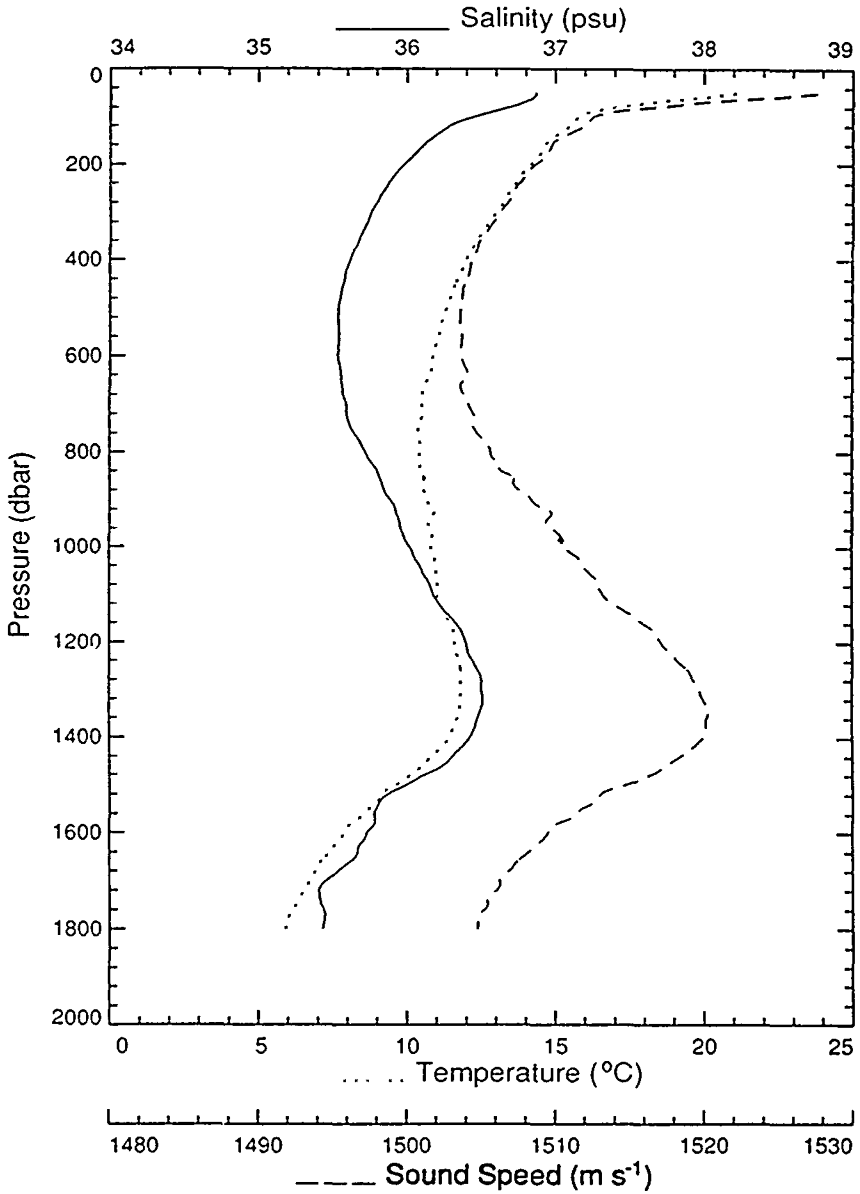

XSV&XBT 011&105
Salinity (psu)
34
35
36
37
38
39
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530


XSV&XBT 005&058
Salinity (psu)
34
35
36
37
38
39
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530

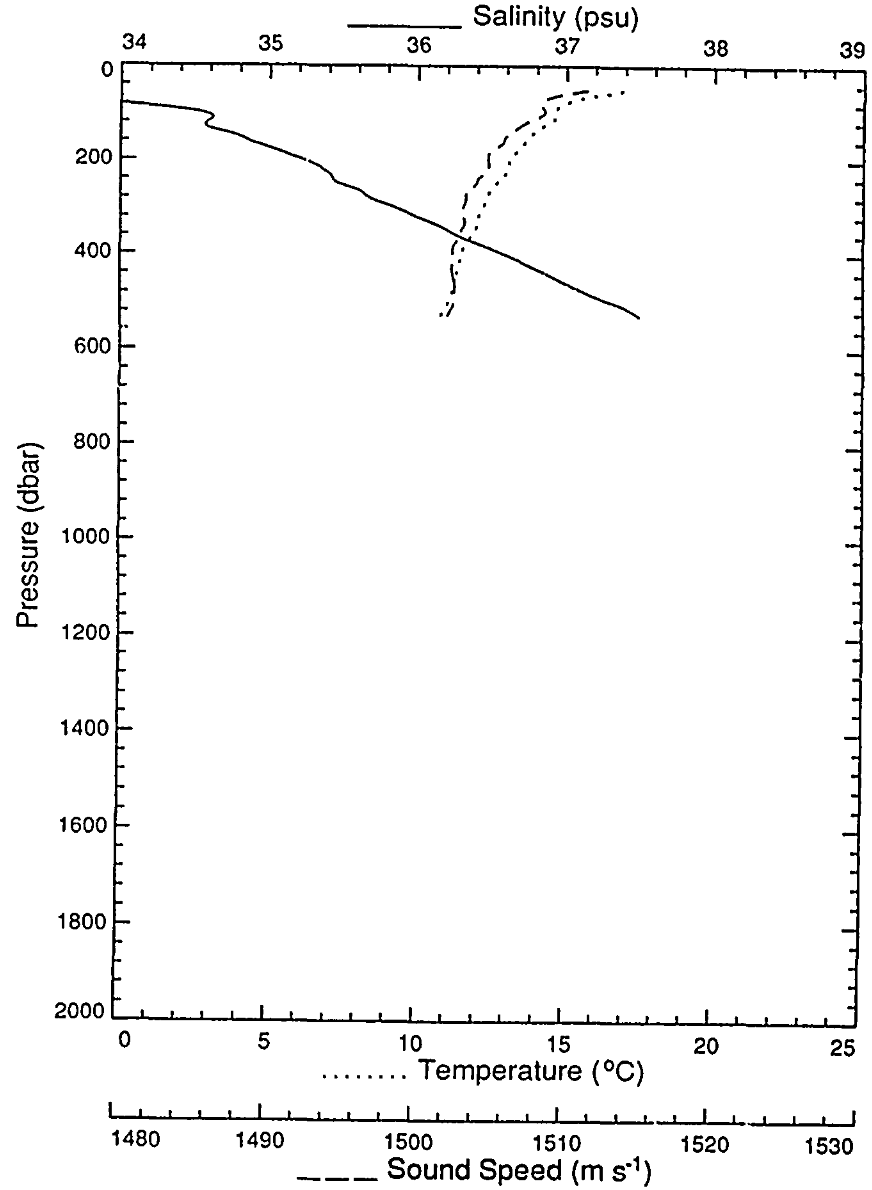

XSV&XBT 012&106
Salinity (psu)
34 35 36 37 38 39
Pressure (dbar)
0 200 400 600 800 1000 1200 1400 1600 1800 2000
0 5 10 15 20 25
Temperature (°C)
1480 1490 1500 1510 1520 1530
Sound Speed (m s-1)

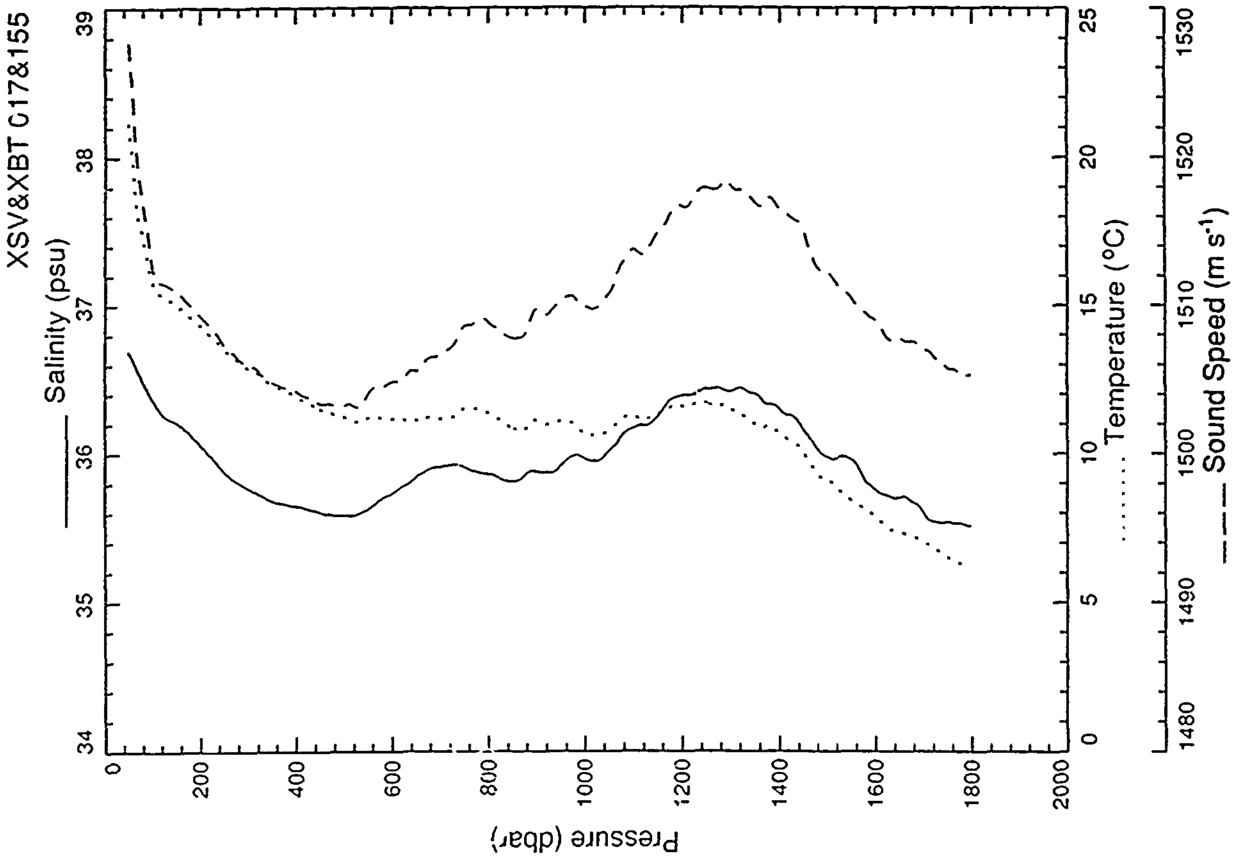

XSV&XBT 013&107
Salinity (psu)
34 35 36 37 38 39
Pressure (dbar)
0 200 400 600 800 1000 1200 1400 1600 1800 2000
0 5 10 15 20 25
Temperature (°C)
1480 1490 1500 1510 1520 1530
Sound Speed (m s-1)

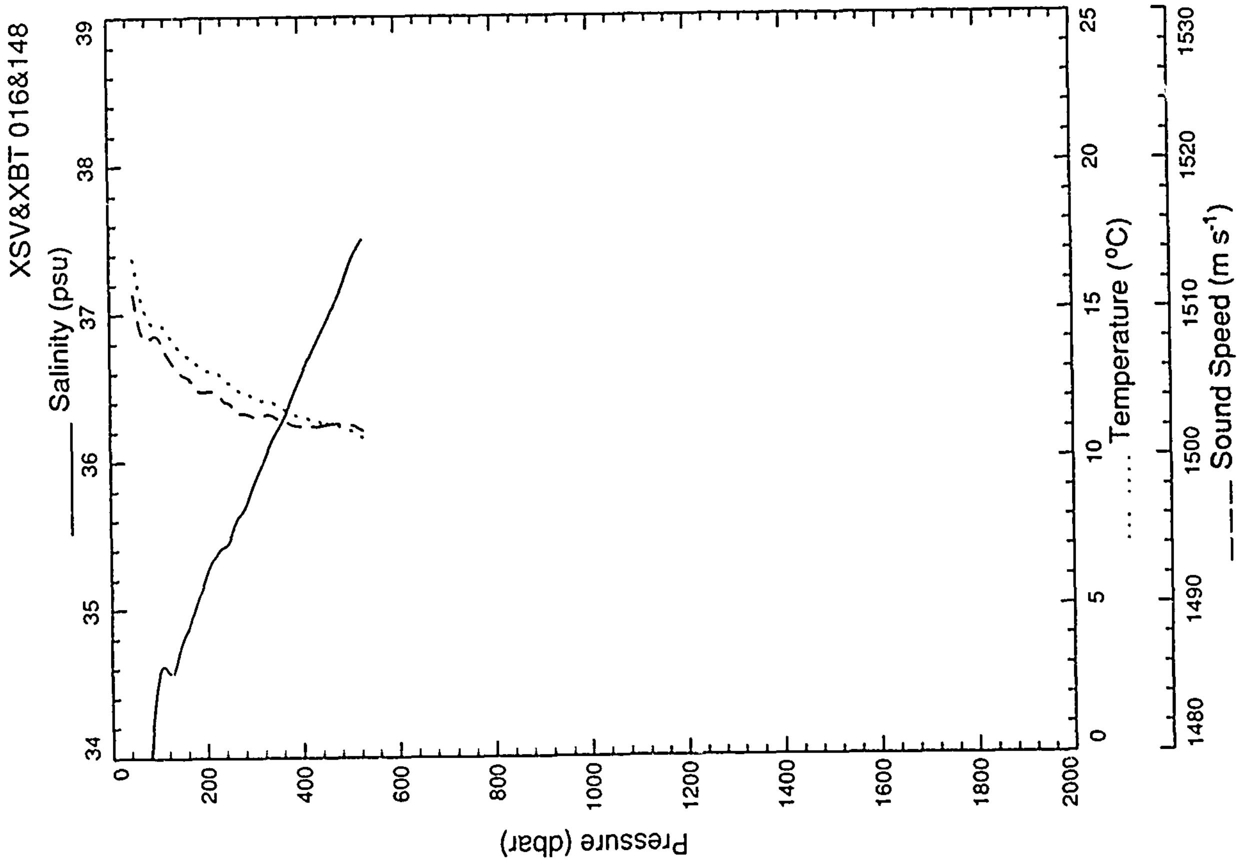
XSV&XBT 014&108

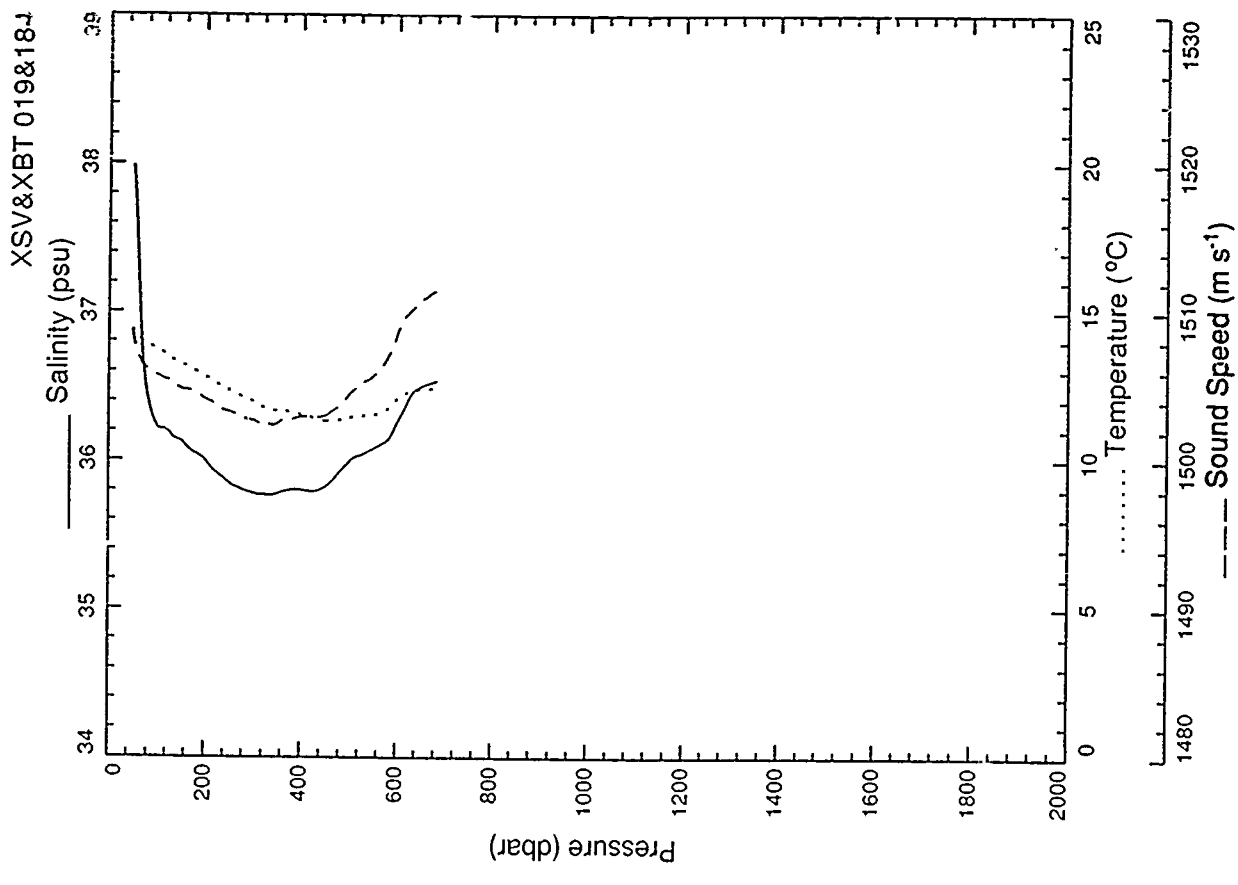


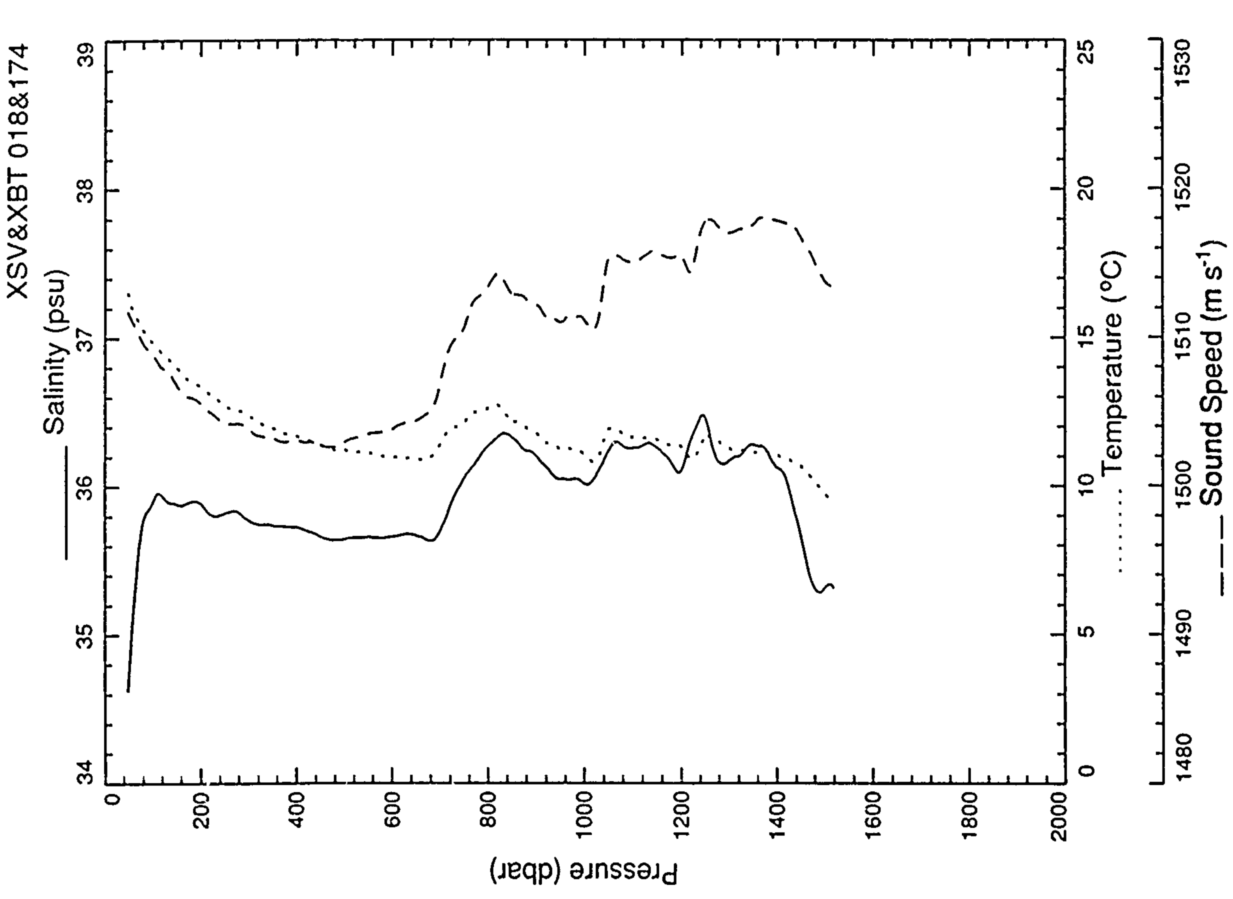
XSV&XBT 016&148

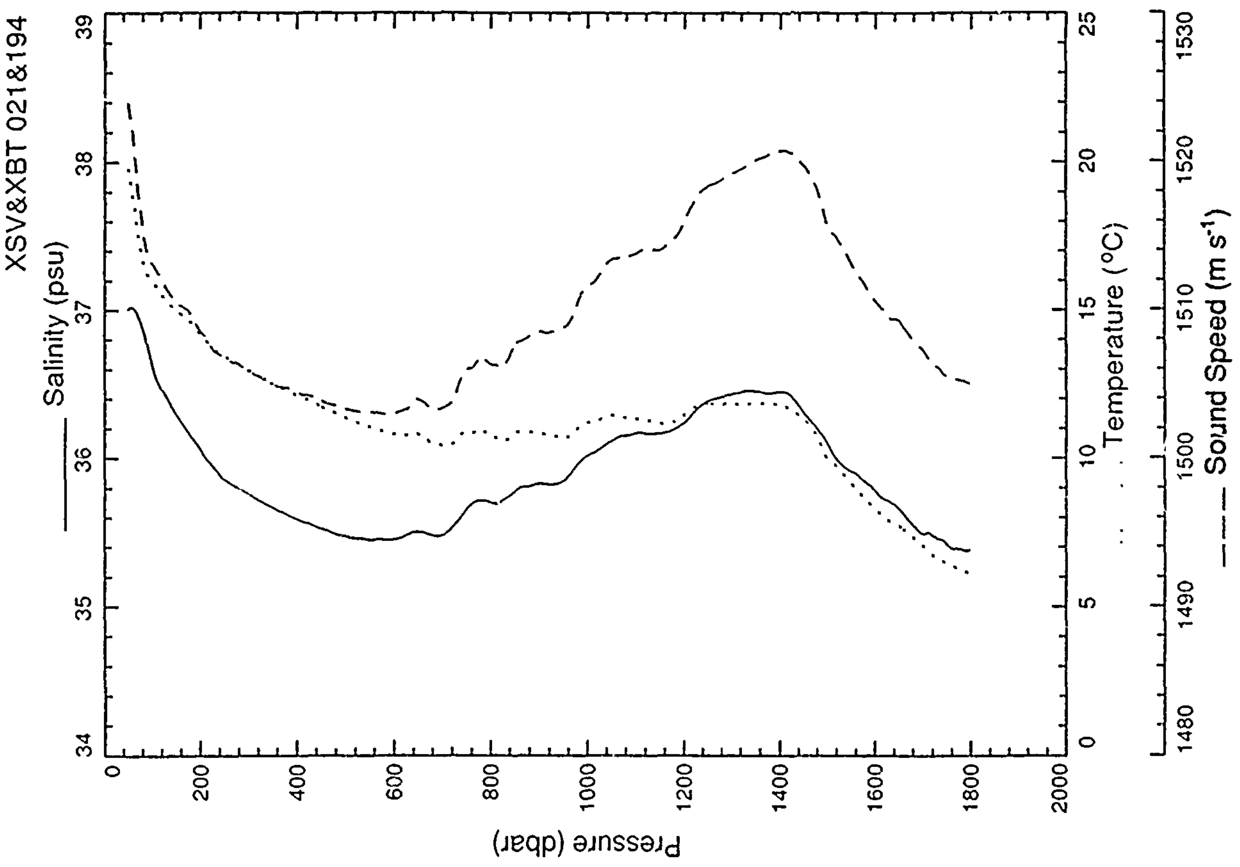


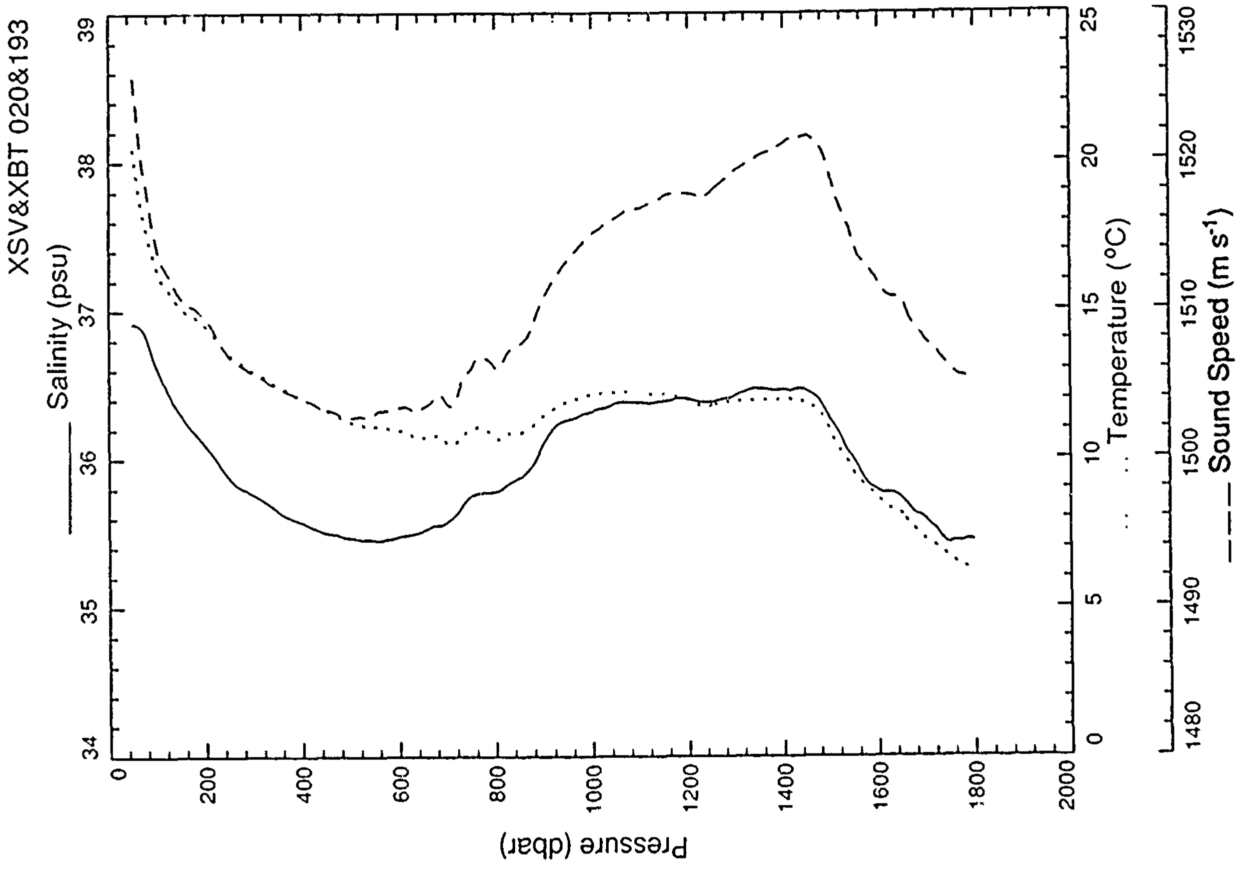

XSV&XBT 017&155
—— Salinity (psu)
34
35
36
37
38
39
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
.... Temperature (°C)
1480
1490
1500
1510
1520
1530
— — — Sound Speed (m s^{-1})

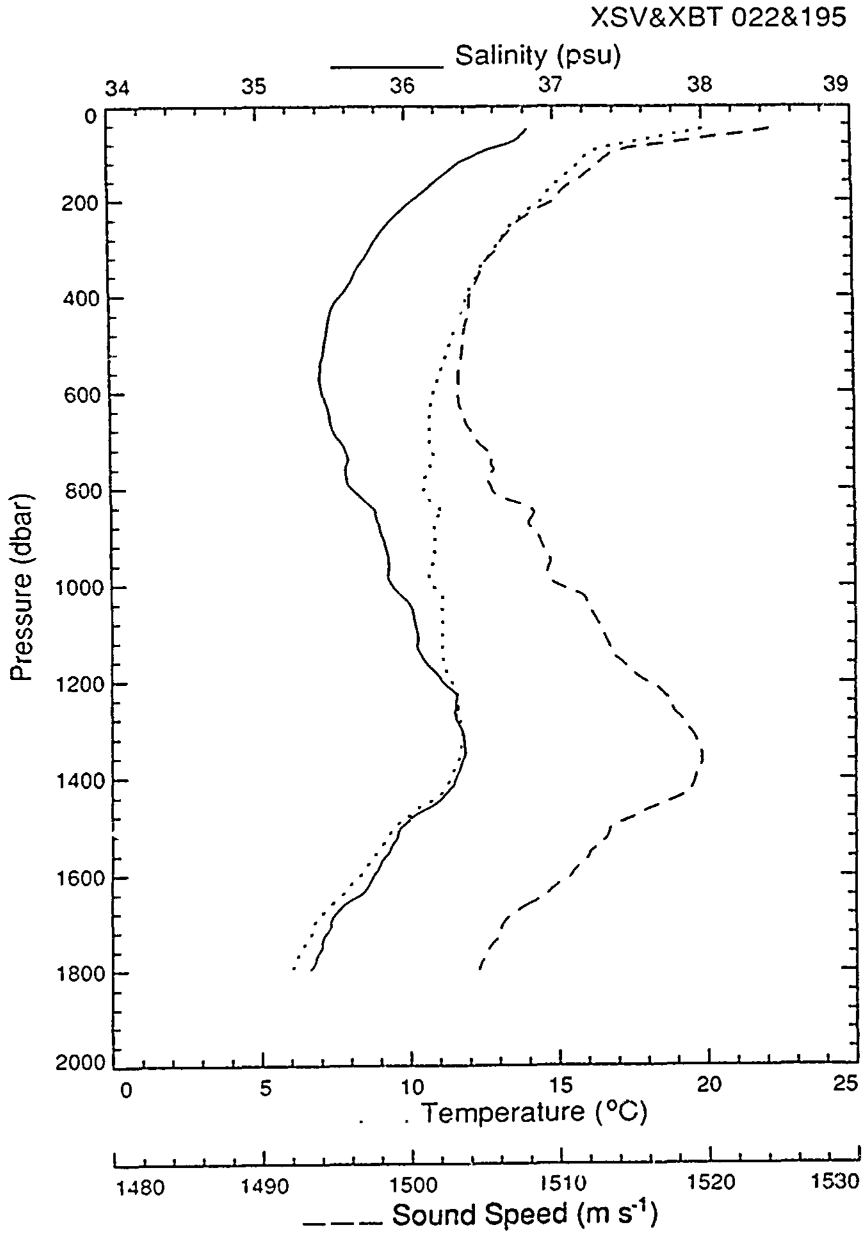

XSV&XBT 016&148
—— Salinity (psu)
34
35
36
37
38
39
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
5
10
15
20
25
.... Temperature (°C)
1480
1490
1500
1510
1520
1530
— — — Sound Speed (m s^{-1})

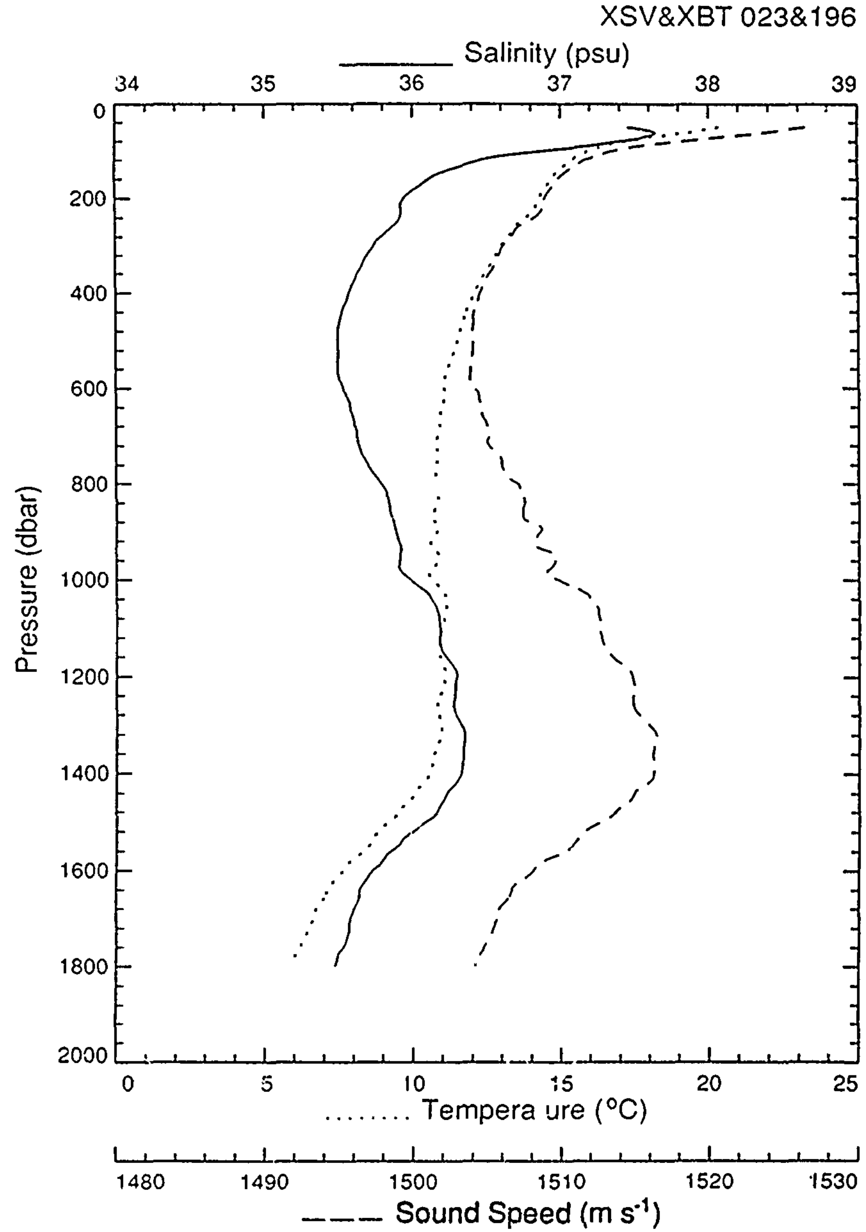

XSV&XBT 019&18
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

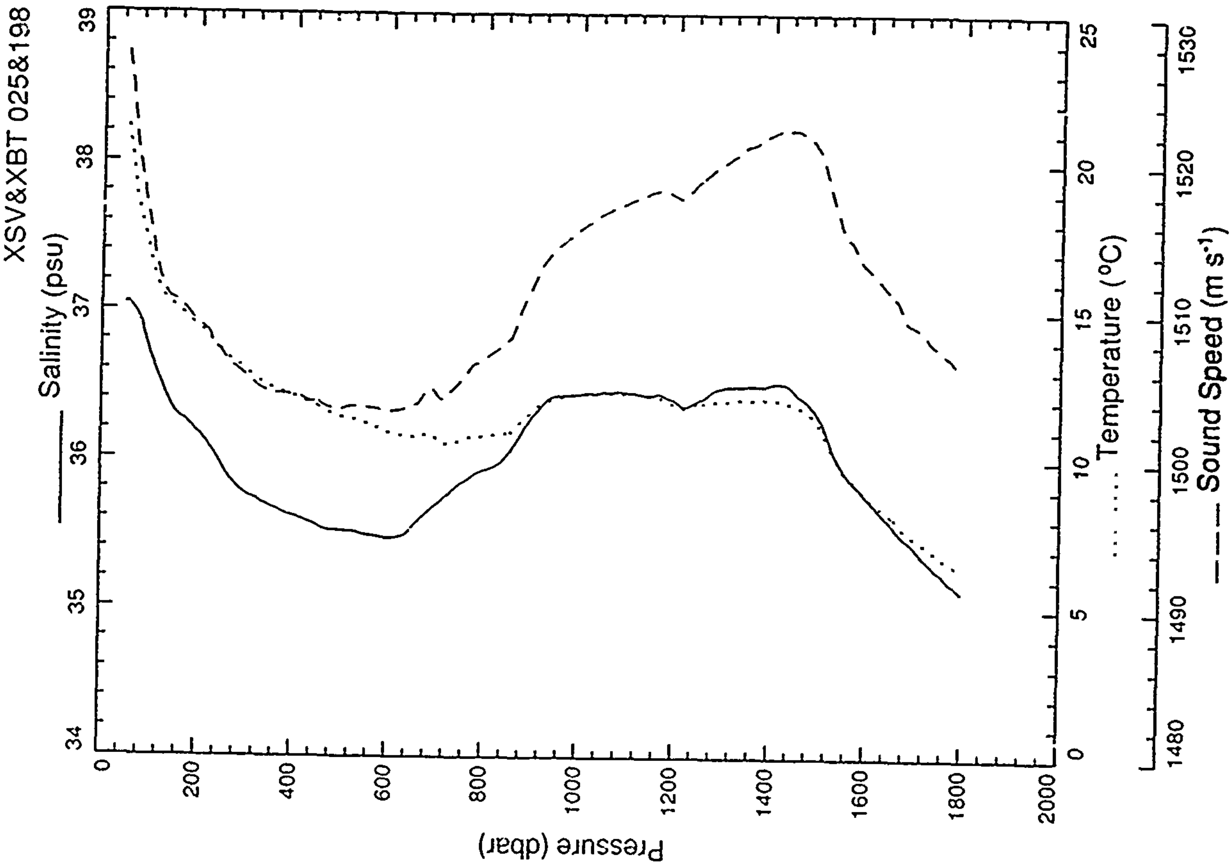

XSV&XBT 018&174
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 021&194
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

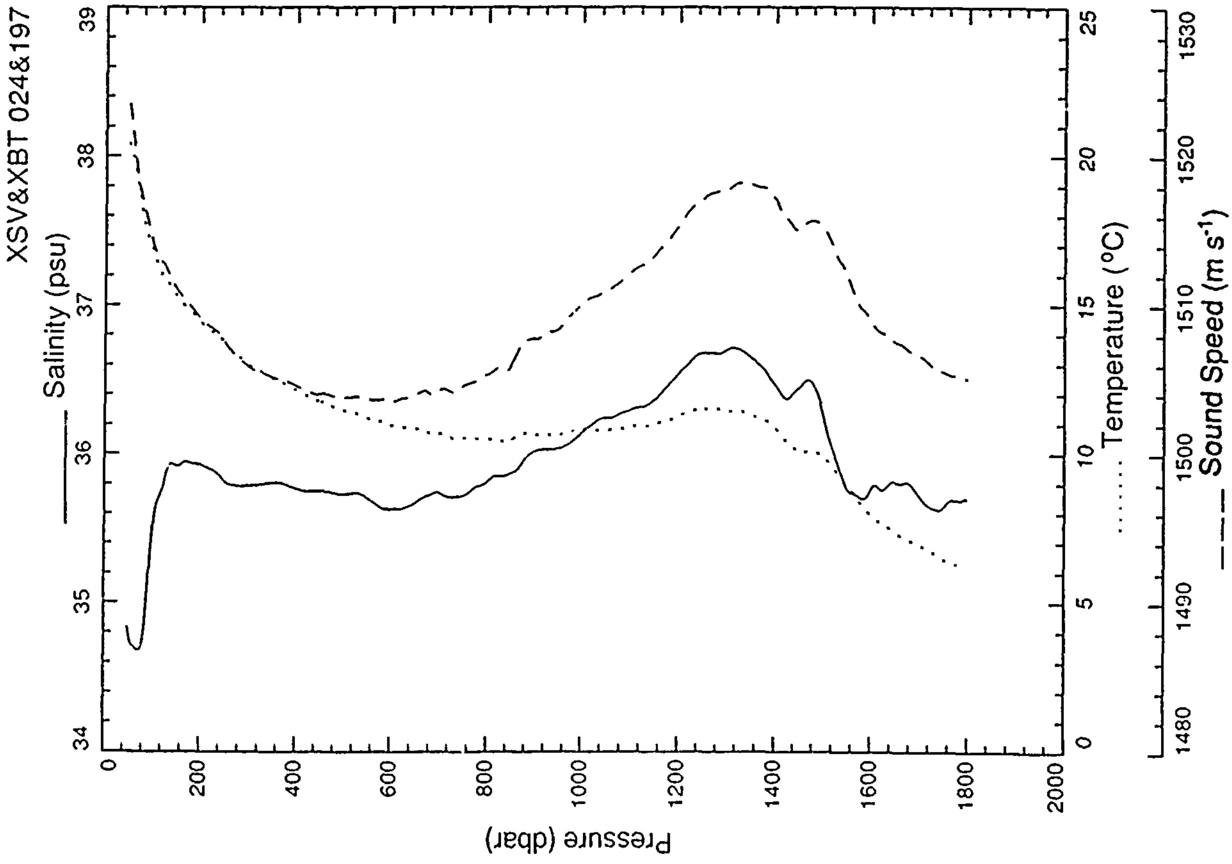

XSV&XBT 020&193
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 022&195
Salinity (psu)
Pressure (dbar)
Temperature (°C)
Sound Speed (m s-1)

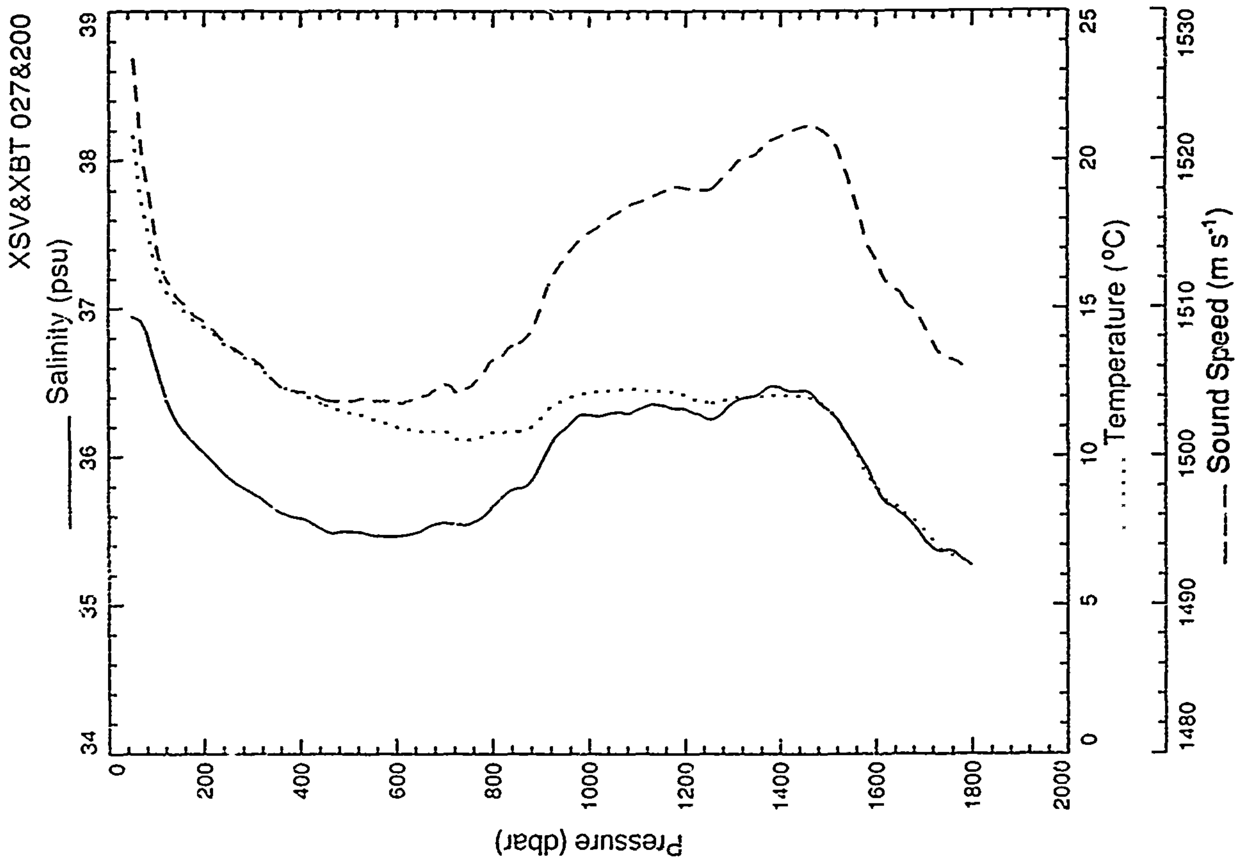

XSV&XBT 023&196
Salinity (psu)
Pressure (dbar)
Tempera ure (°C)
Sound Speed (m s-1)

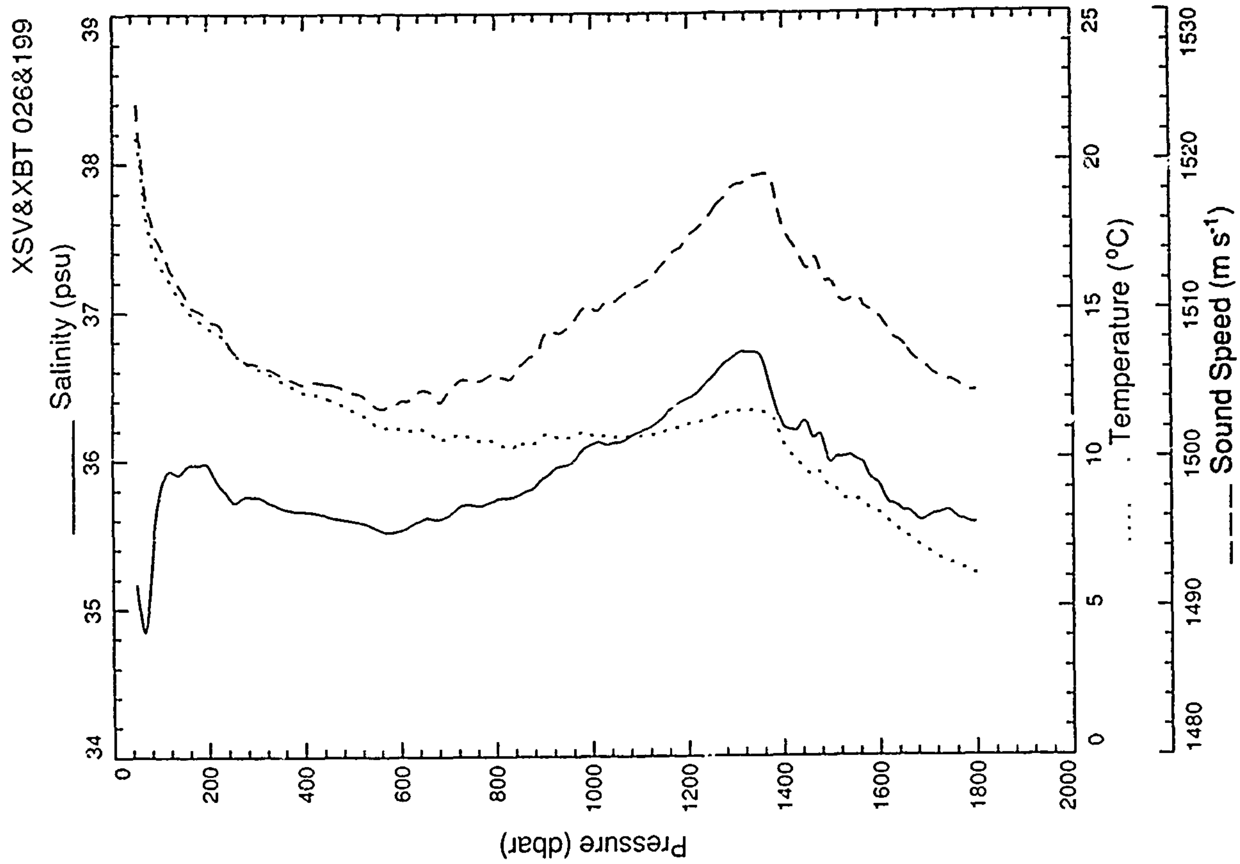


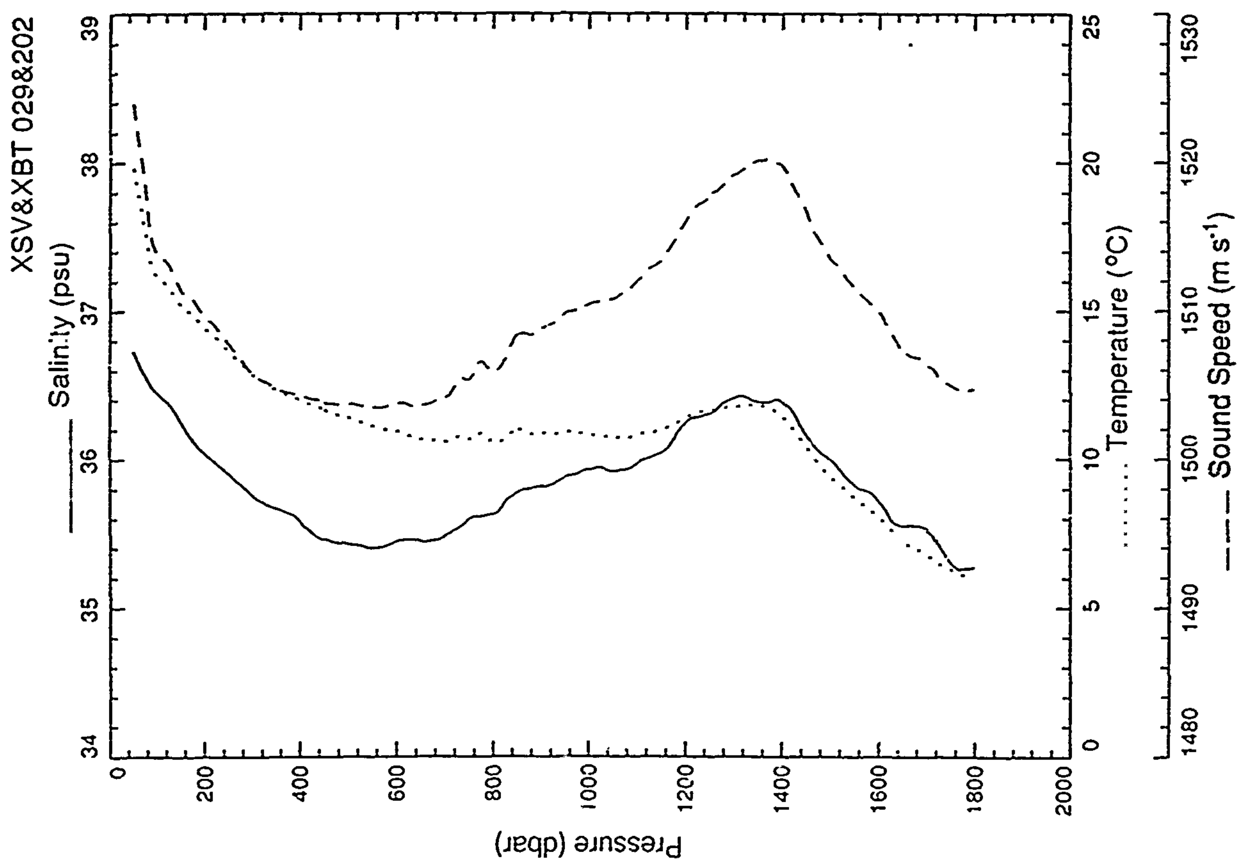
XSV&XBT 025&198
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

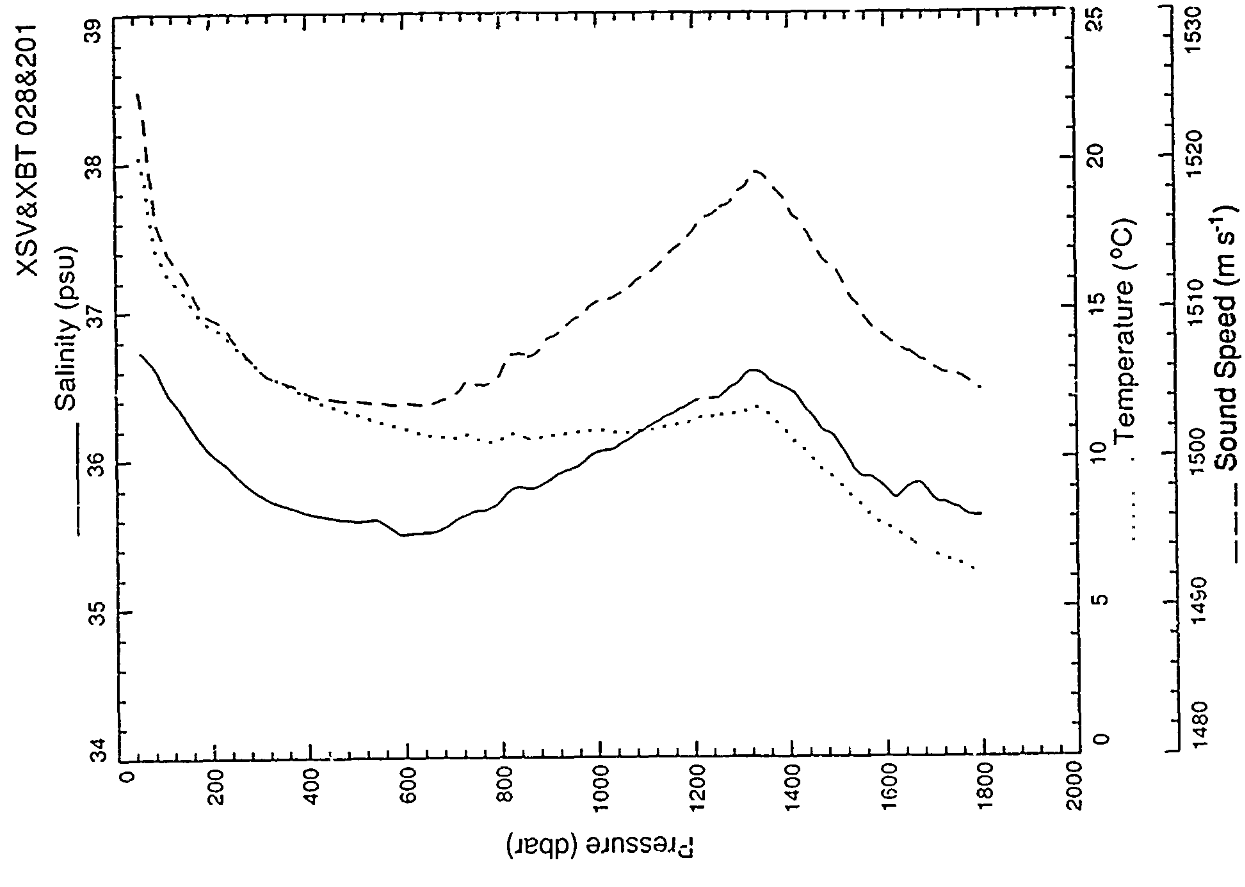


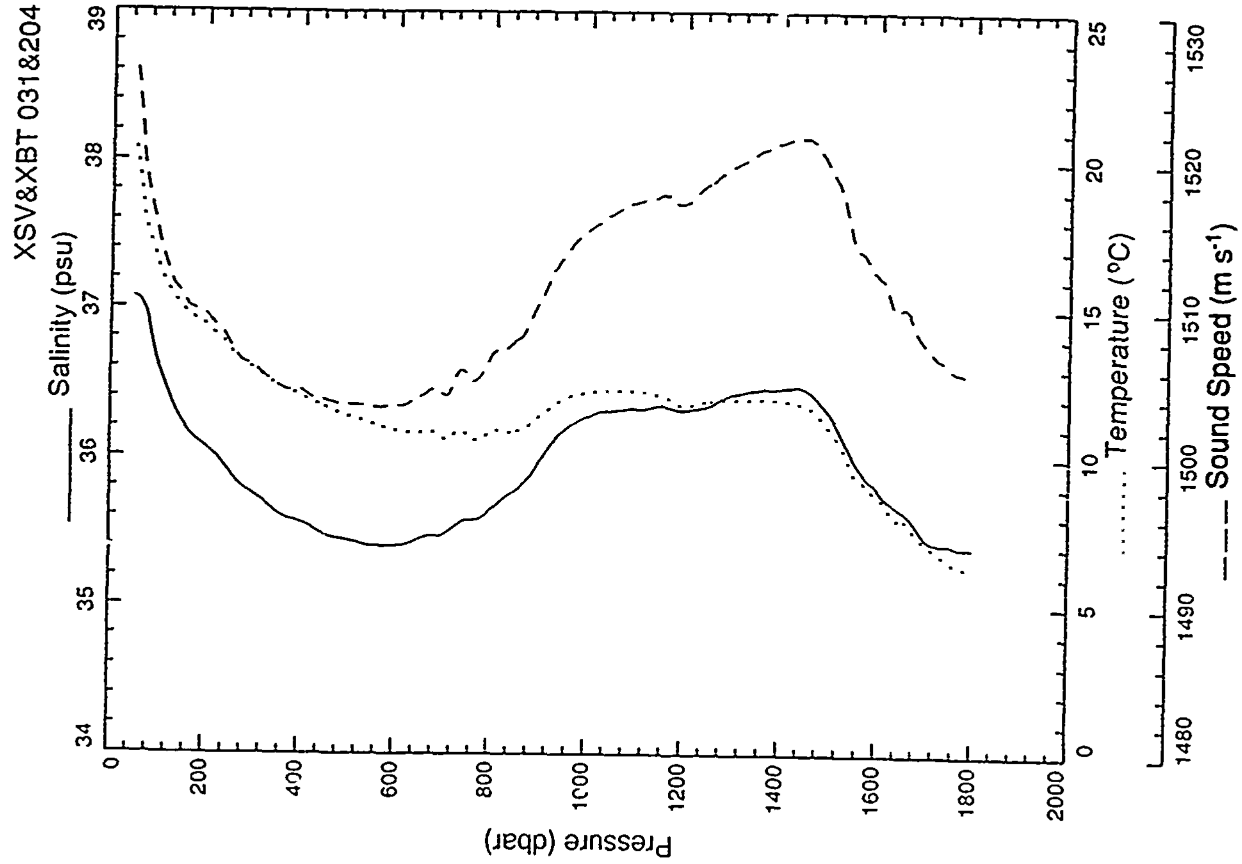
XSV&XBT 024&197
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

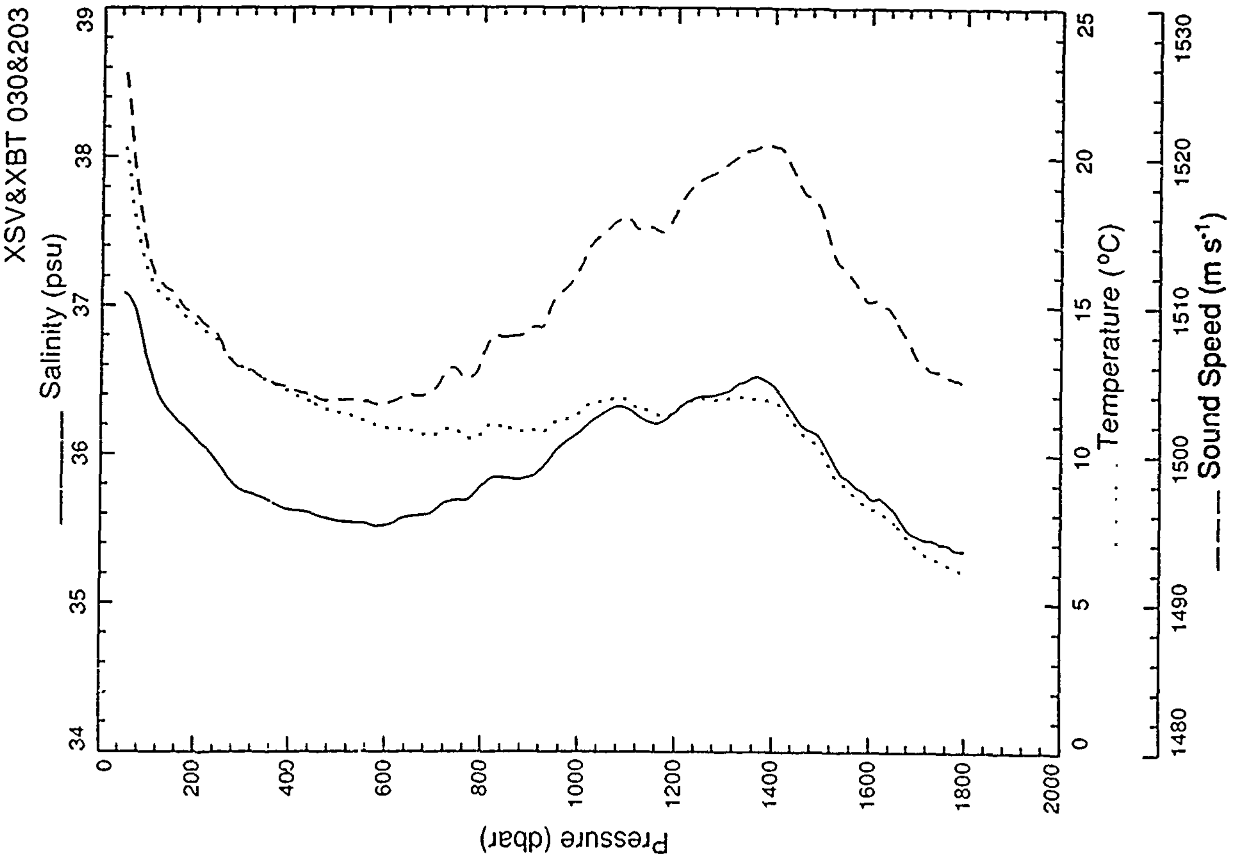

XSV&XBT 027&200
Salinity (psu)
34 35 36 37 38 39
Temperature (ºC)
0 5 10 15 20 25
Sound Speed (m s-1)
1480 1490 1500 1510 1520 1530
Pressure (dbar)
0 200 400 600 800 1000 1200 1400 1600 1800 2000

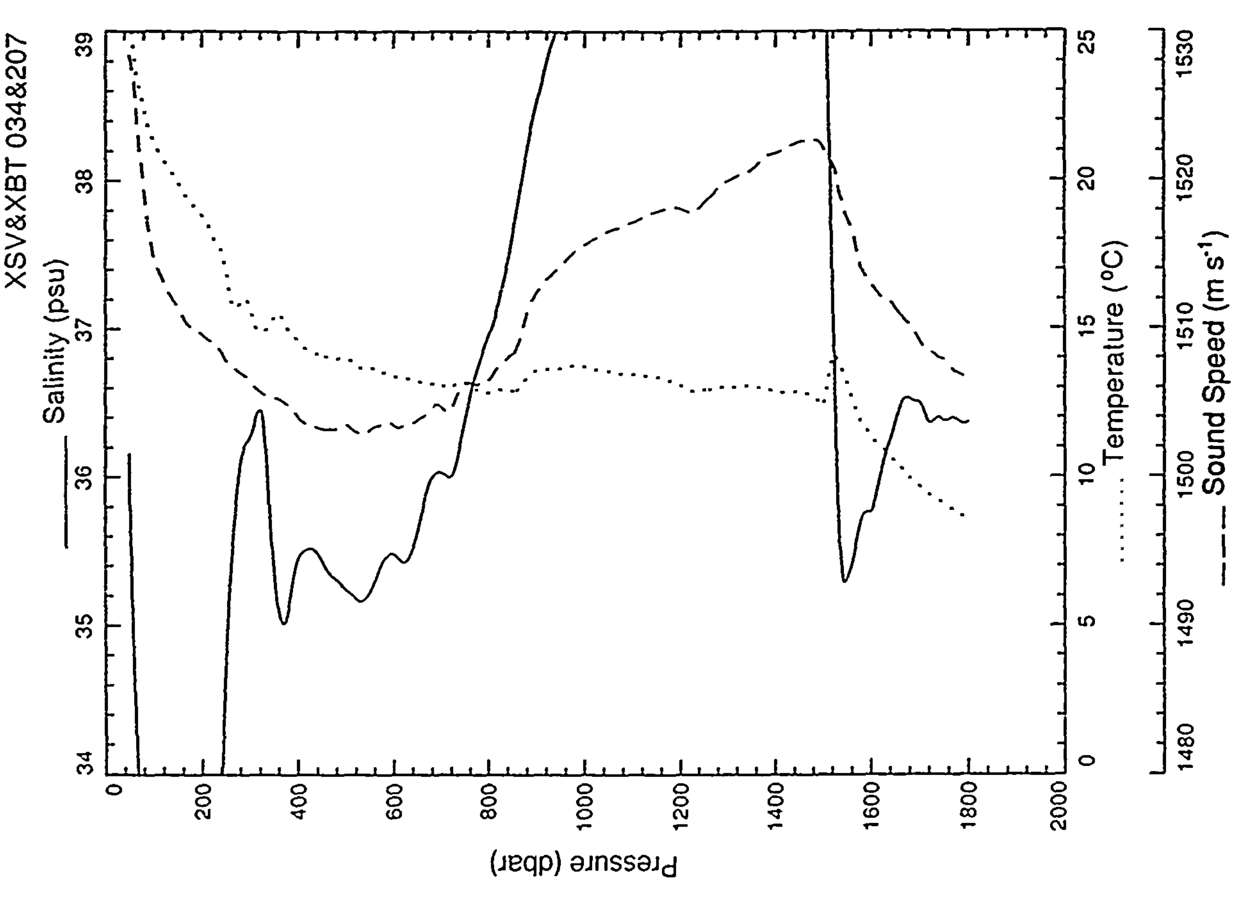

XSV&XBT 026&199
Salinity (psu)
34 35 36 37 38 39
Temperature (ºC)
0 5 10 15 20 25
Sound Speed (m s-1)
1480 1490 1500 1510 1520 1530
Pressure (dbar)
0 200 400 600 800 1000 1200 1400 1600 1800 2000


XSV&XBT 029&202
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

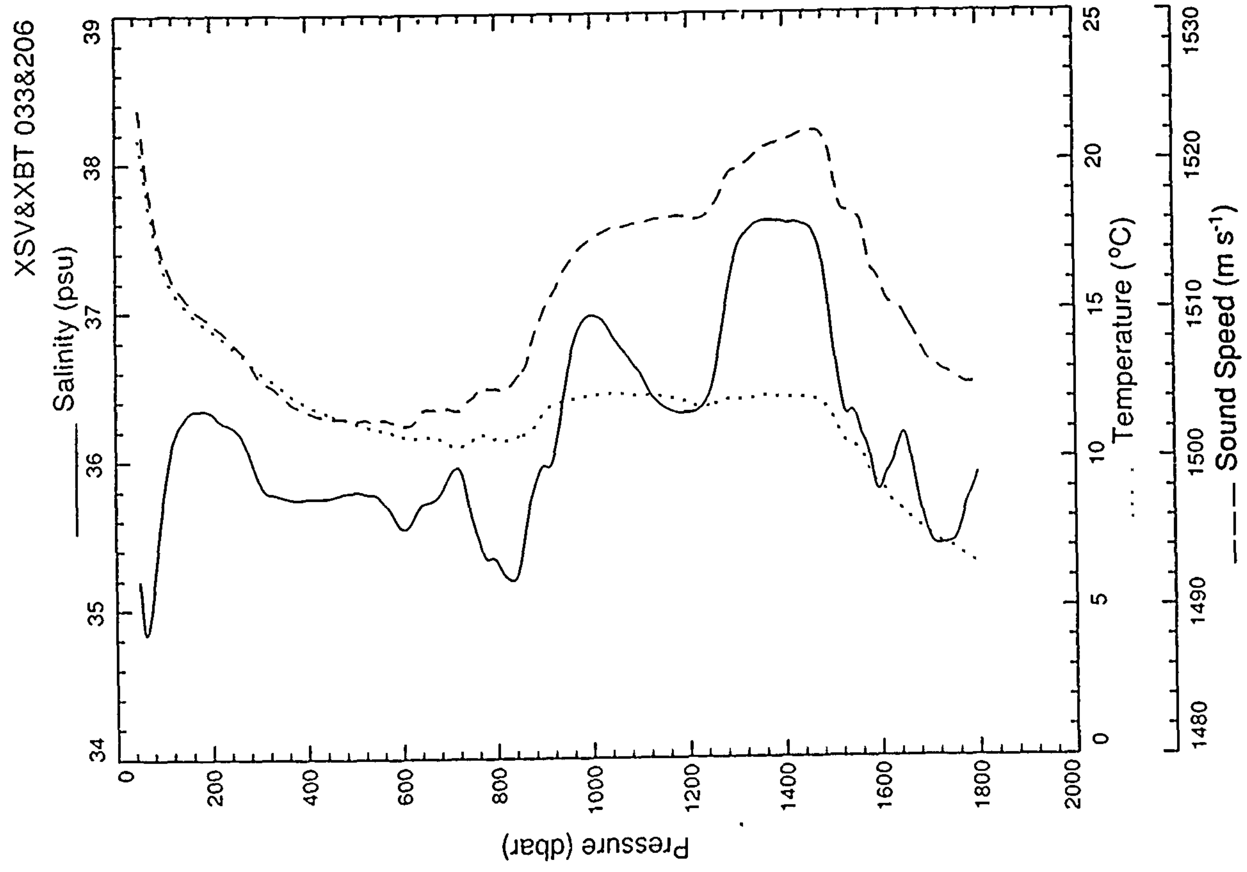

XSV&XBT 028&201
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 031&204
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

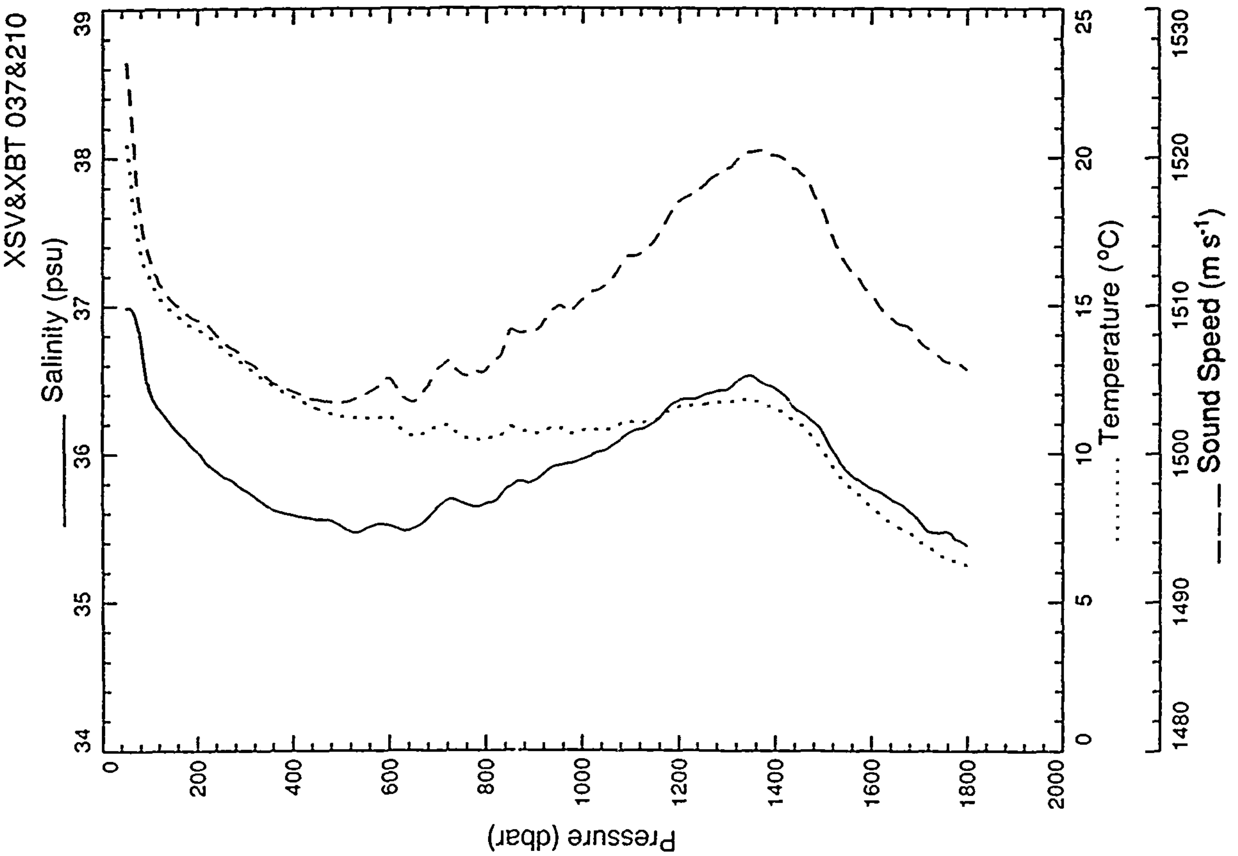

XSV&XBT 030&203
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

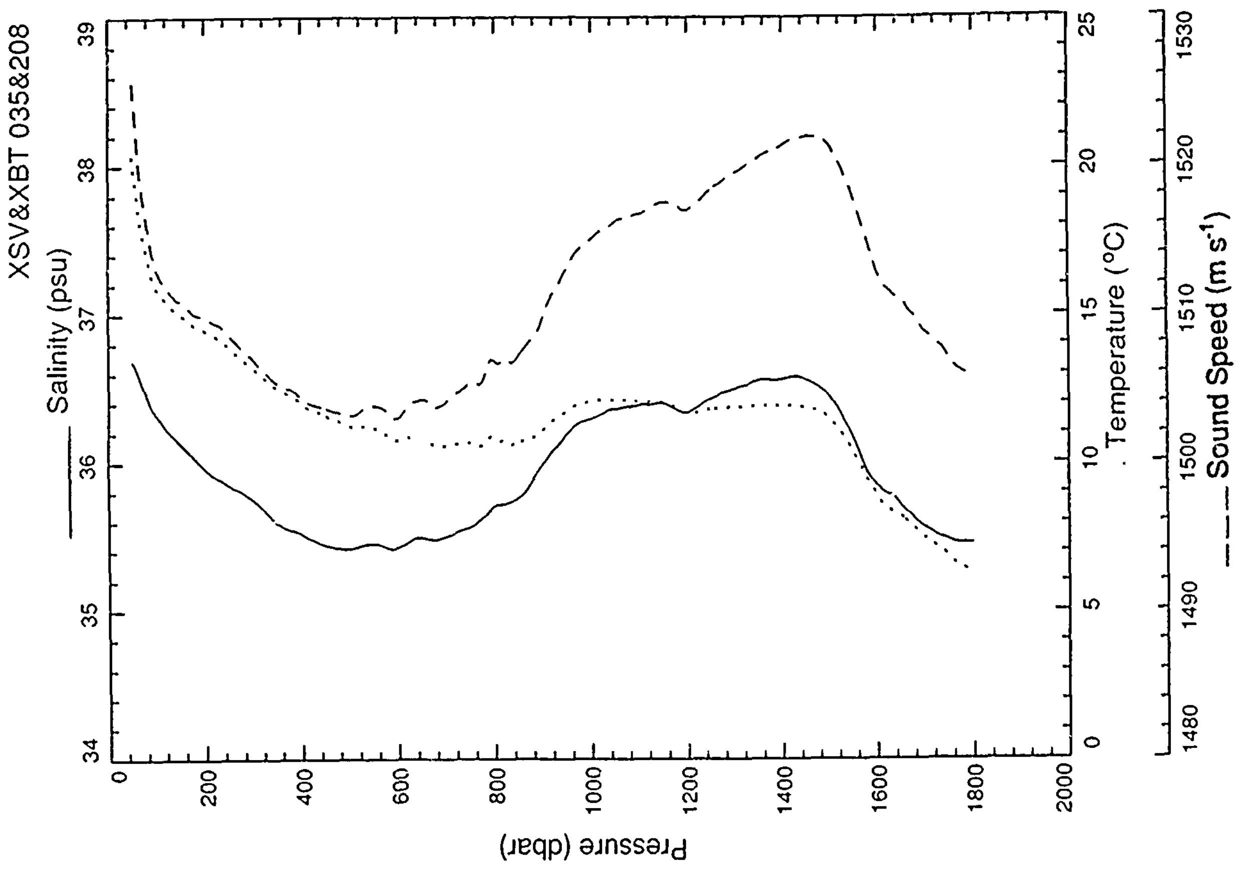


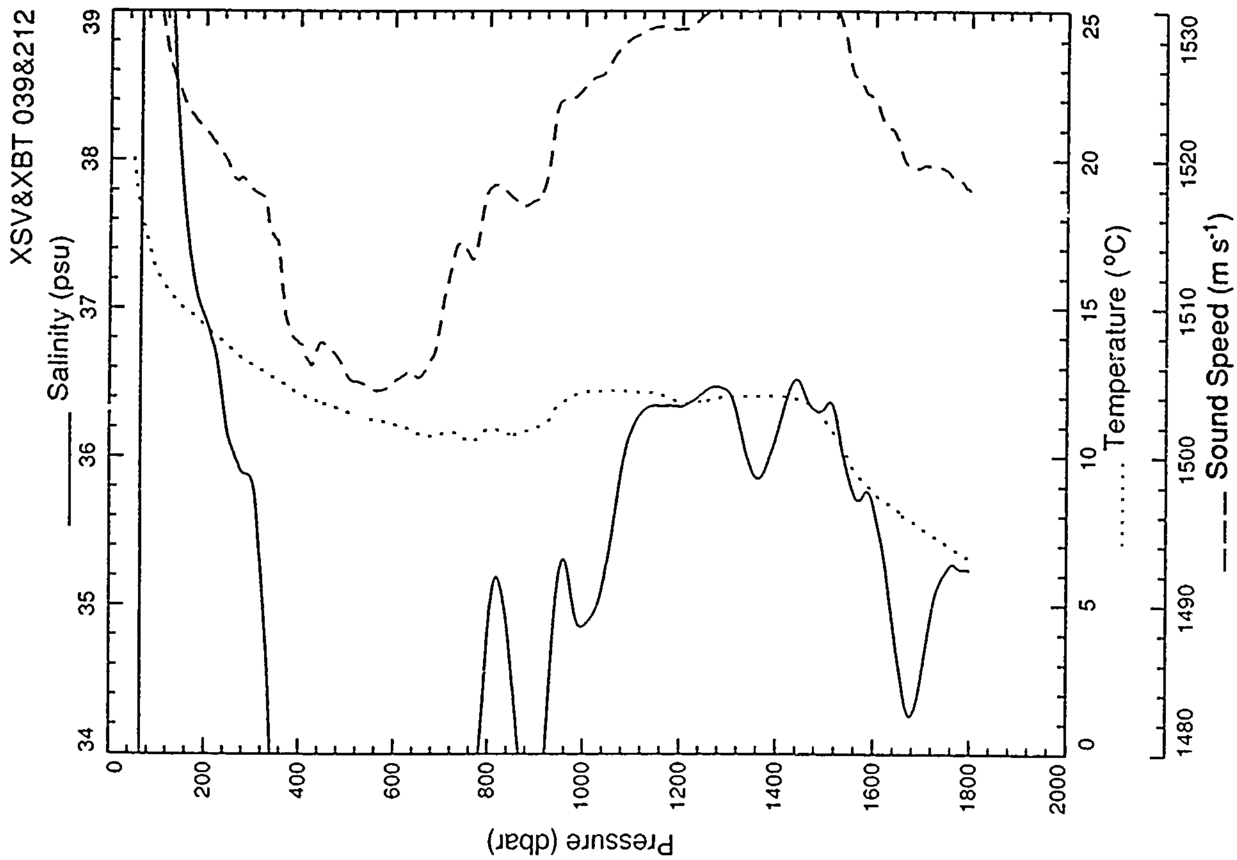
XSV&XBT 034&207
Salinity (psu)
34
35
36
37
38
39
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530

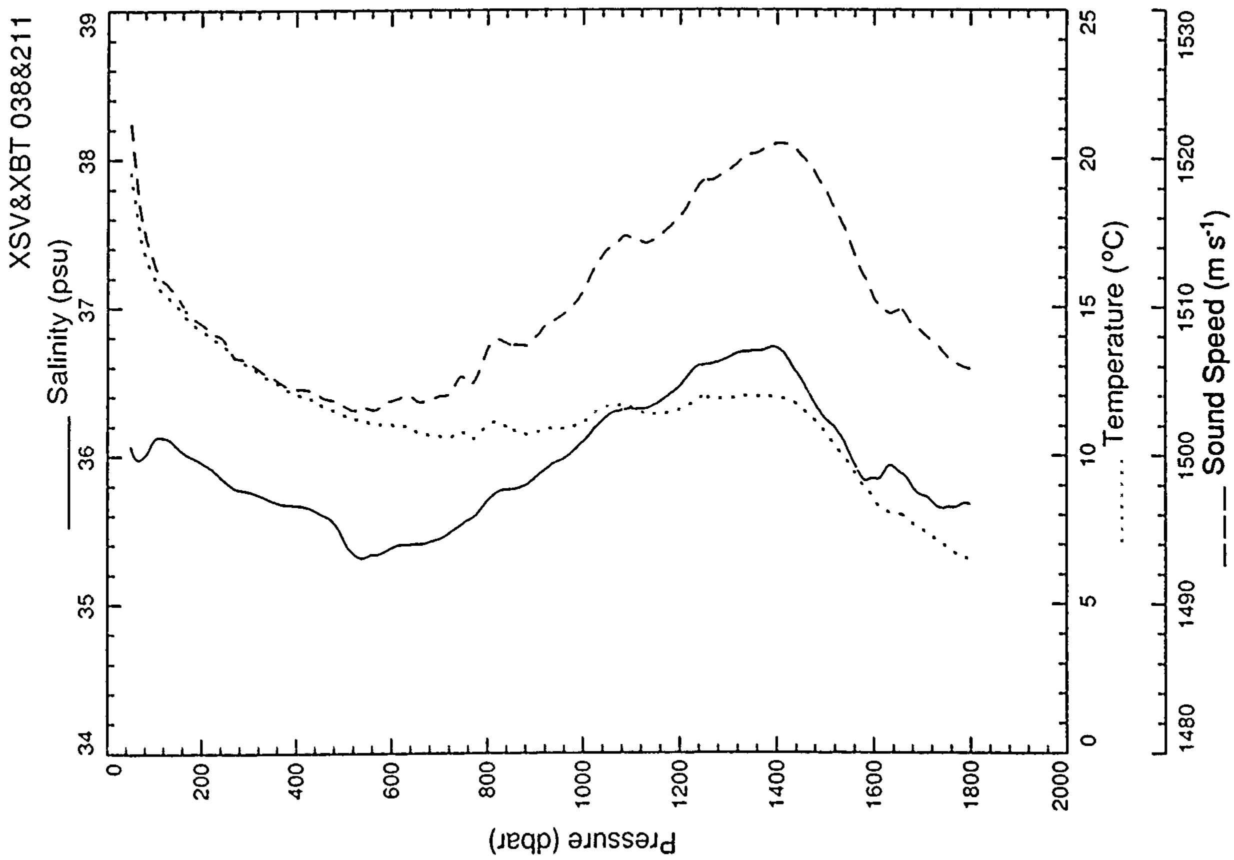


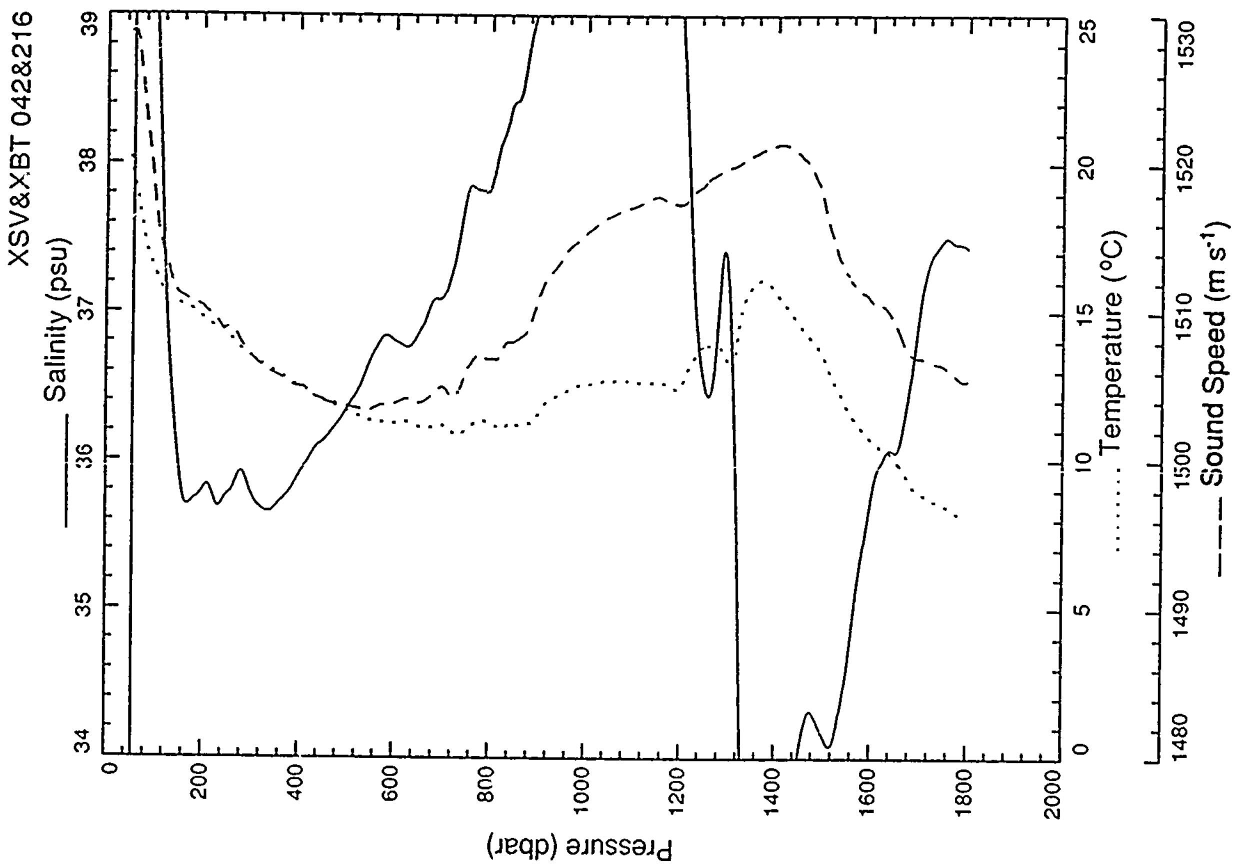
XSV&XBT 033&206
Salinity (psu)
34
35
36
37
38
39
Pressure (dbar)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Temperature (°C)
0
5
10
15
20
25
Sound Speed (m s-1)
1480
1490
1500
1510
1520
1530

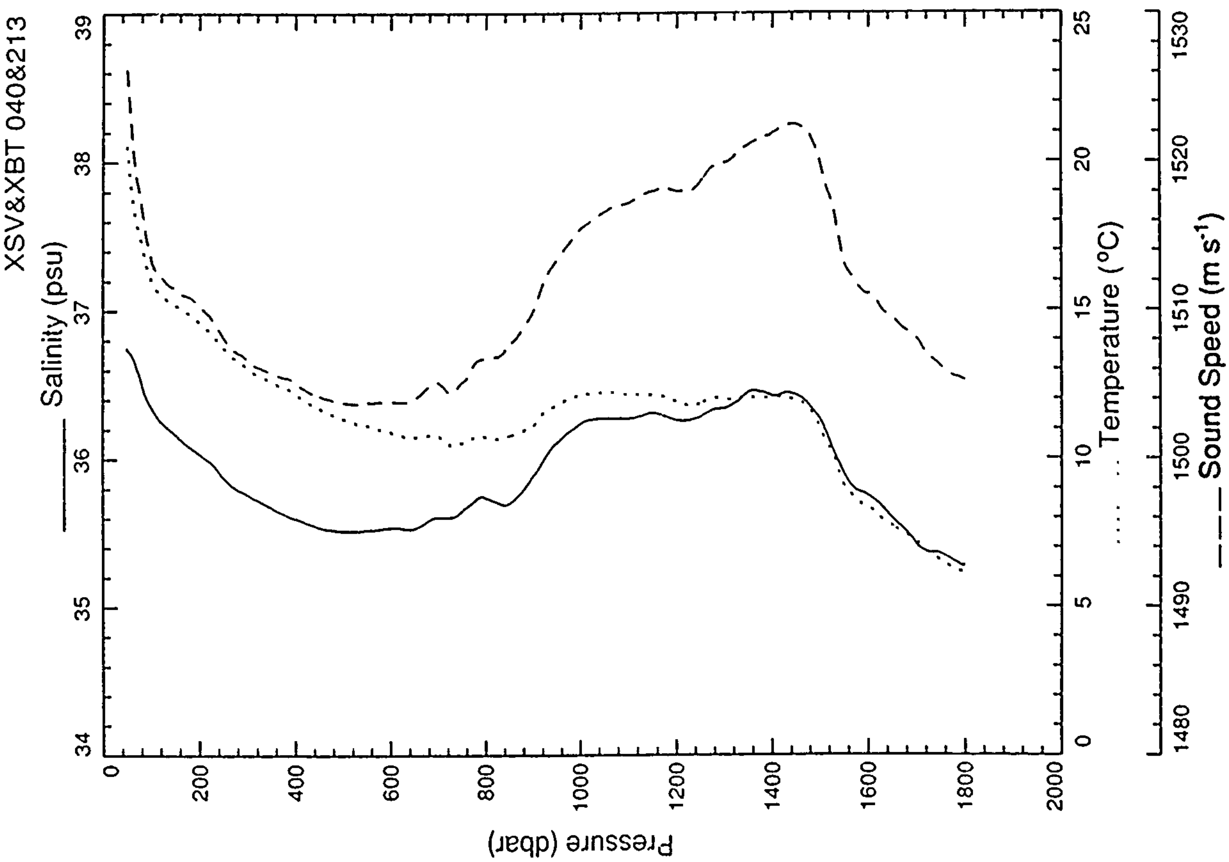

XSV&XBT 037&210
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

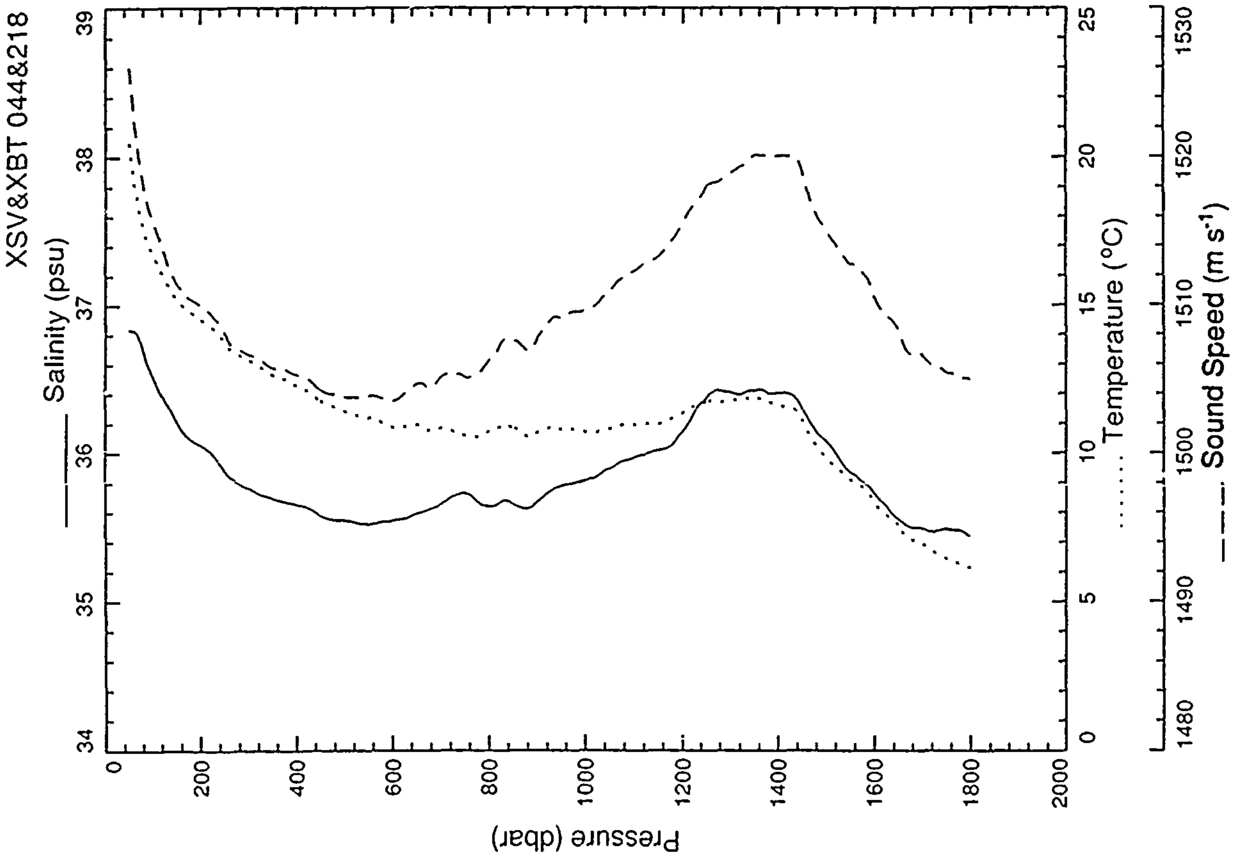

XSV&XBT 035&208
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

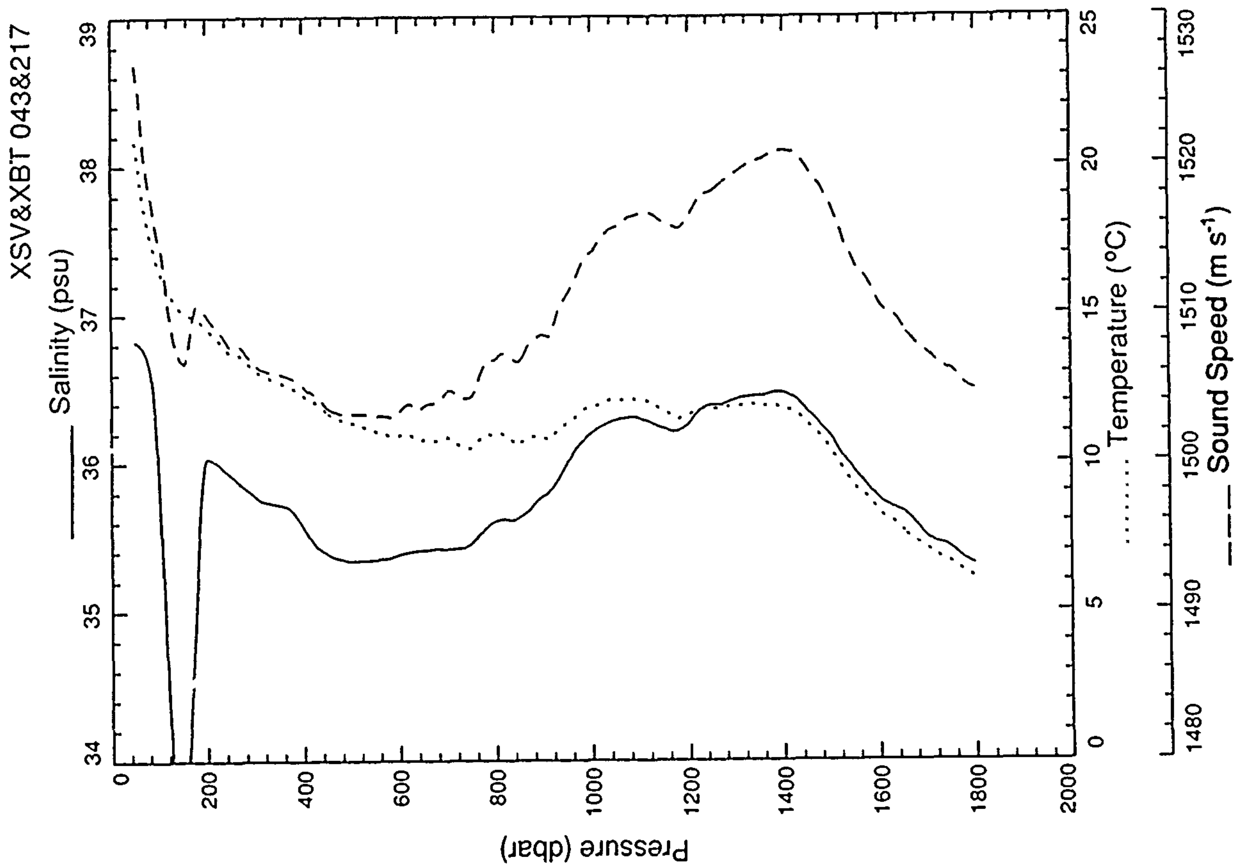

XSV&XBT 039&212
——— Salinity (psu)
.... Temperature (°C)
— — — Sound Speed (m s-1)
Pressure (dbar)

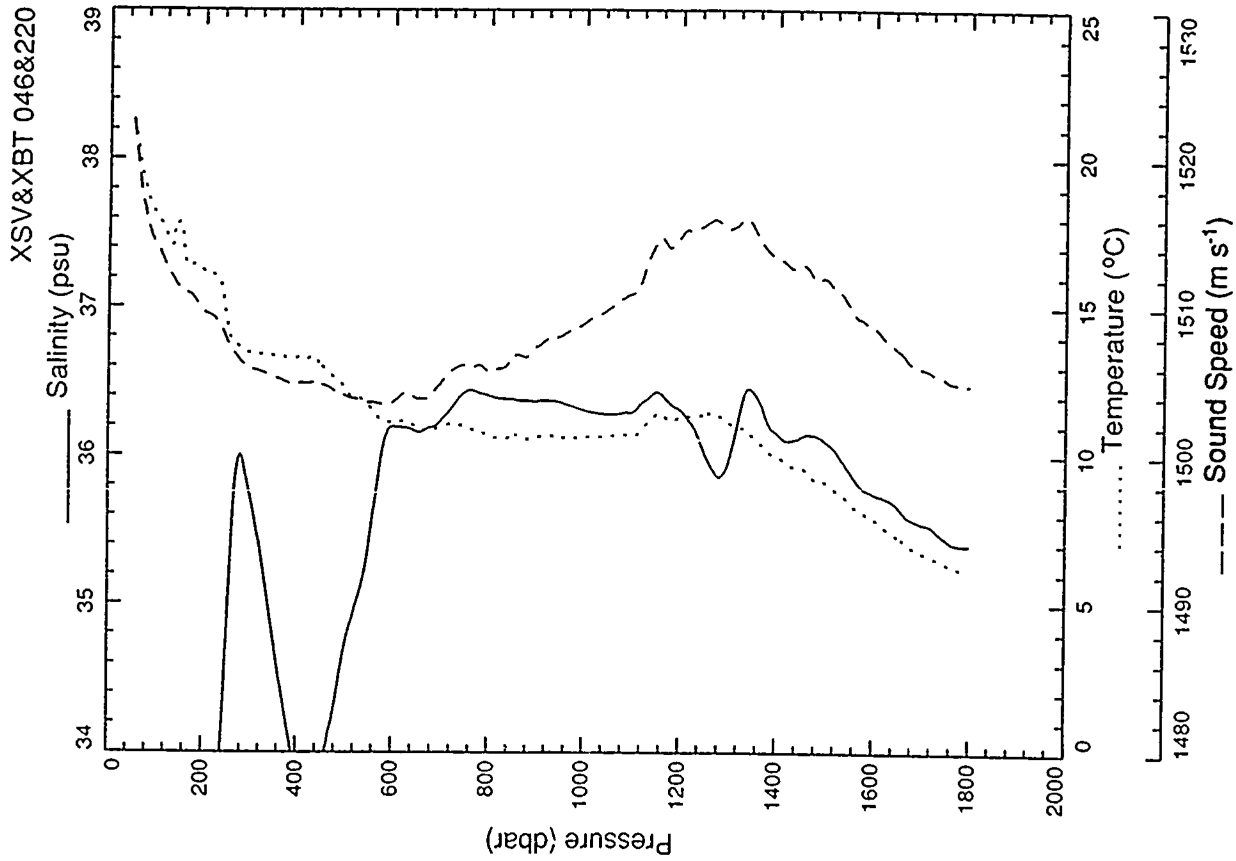

XSV&XBT 038&211
——— Salinity (psu)
.... Temperature (°C)
— — — Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 042&216
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

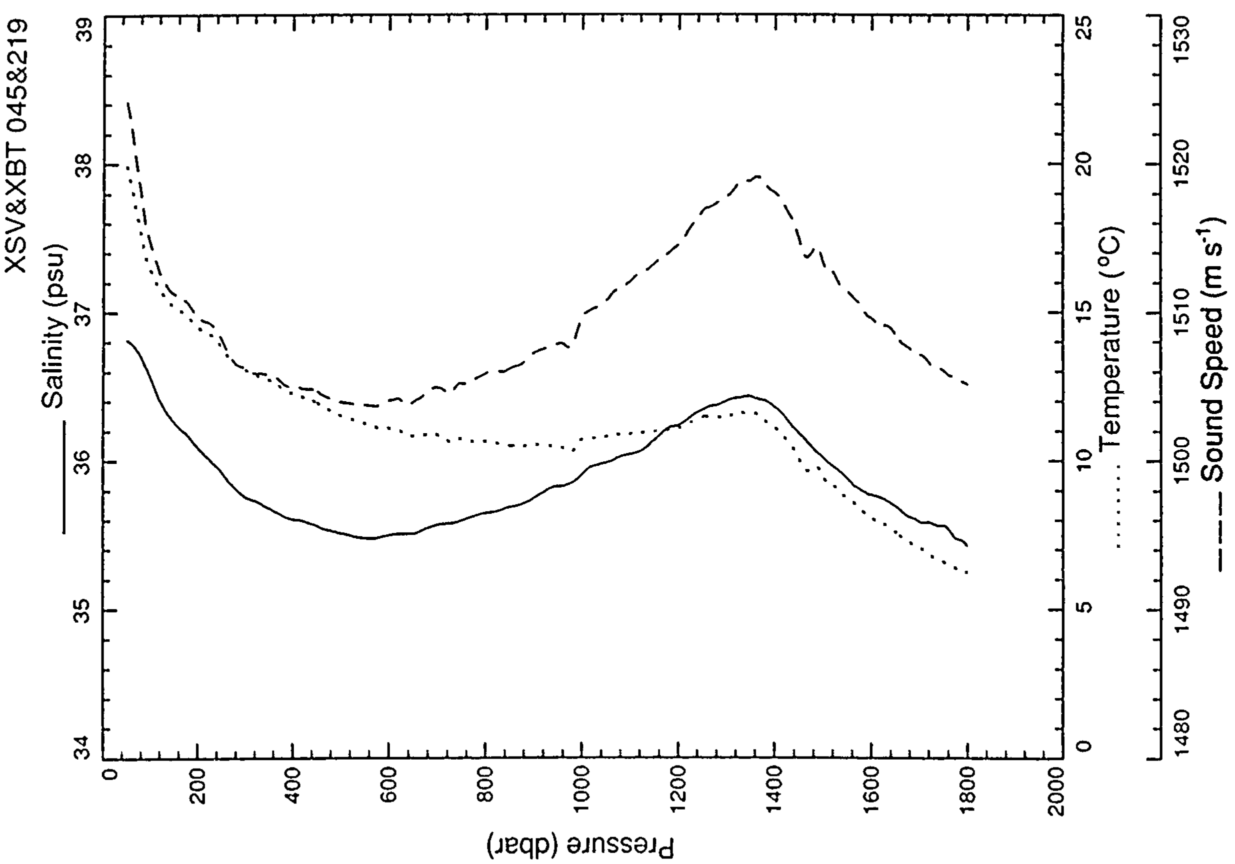

XSV&XBT 040&213
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 044&218
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

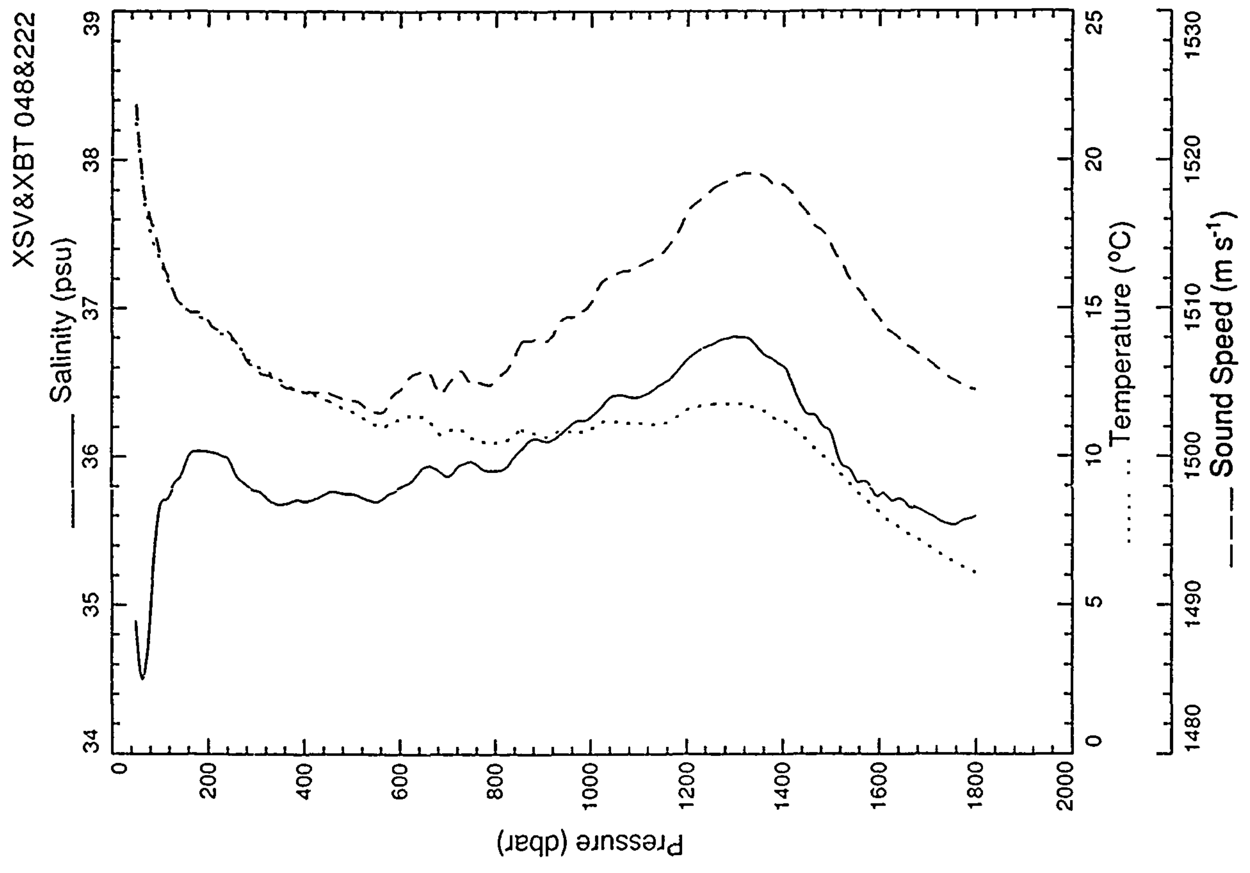

XSV&XBT 043&217
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

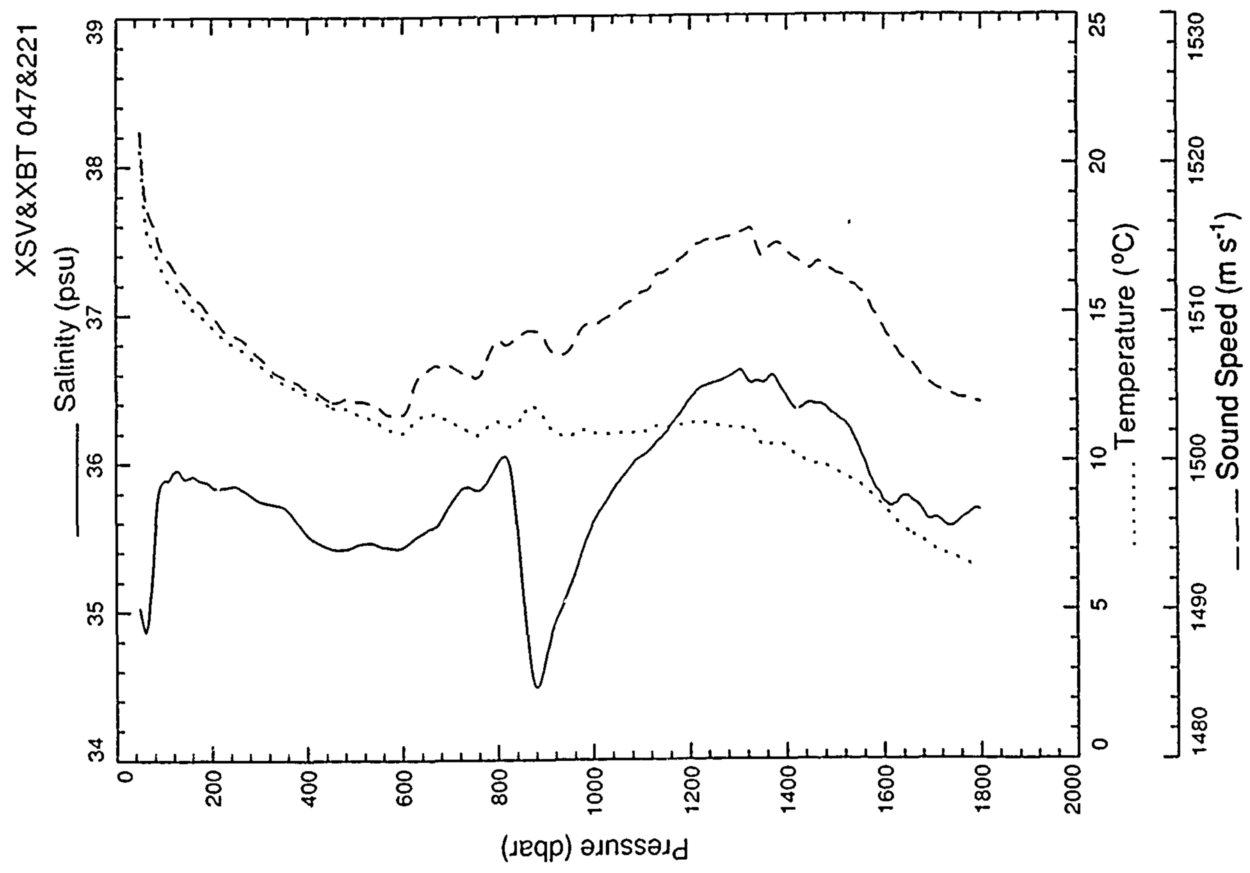


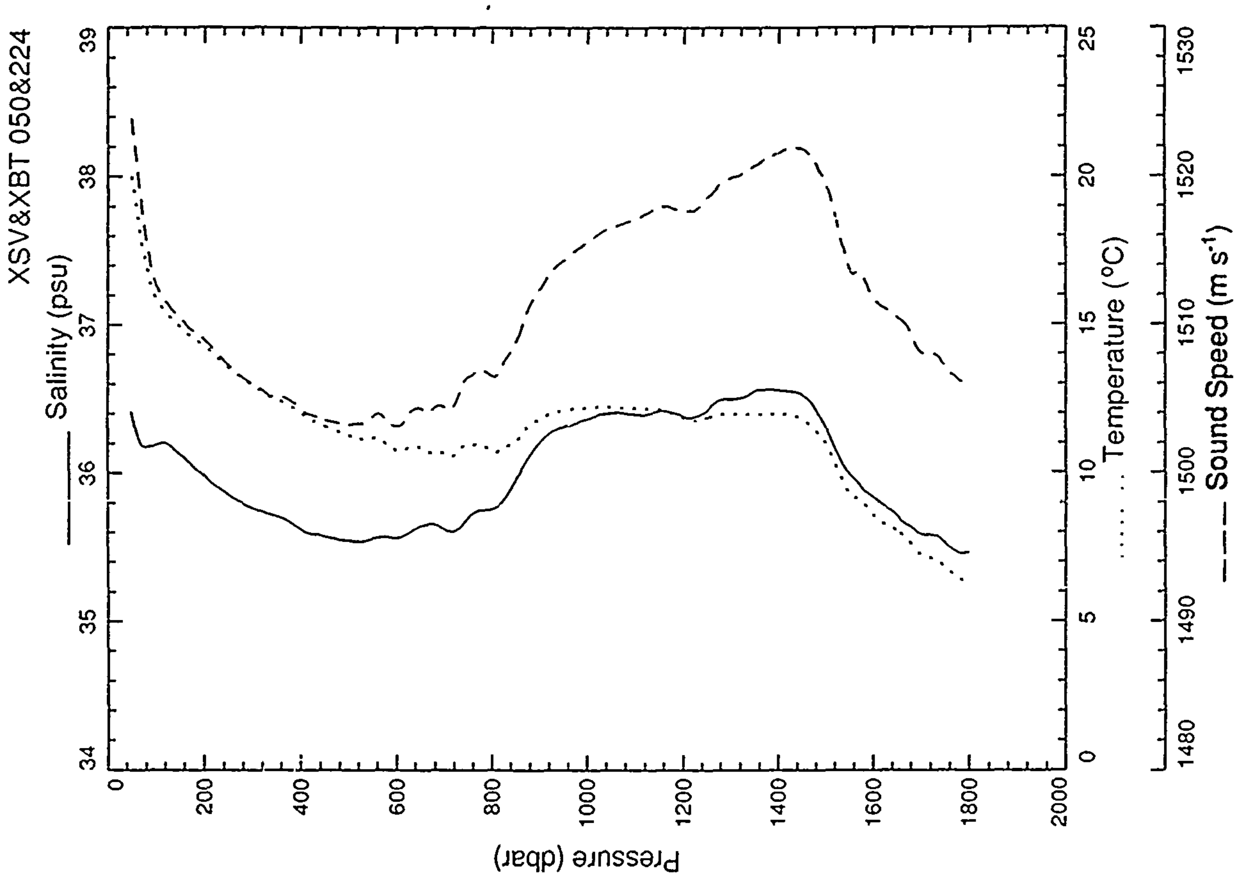
XSV&XBT 046&220
Salinity (psu)
34 35 36 37 38 39
Temperature (°C)
0 5 10 15 20 25
Sound Speed (m s-1)
1480 1490 1500 1510 1520 1530
Pressure (dbar)
0 200 400 600 800 1000 1200 1400 1600 1800 2000

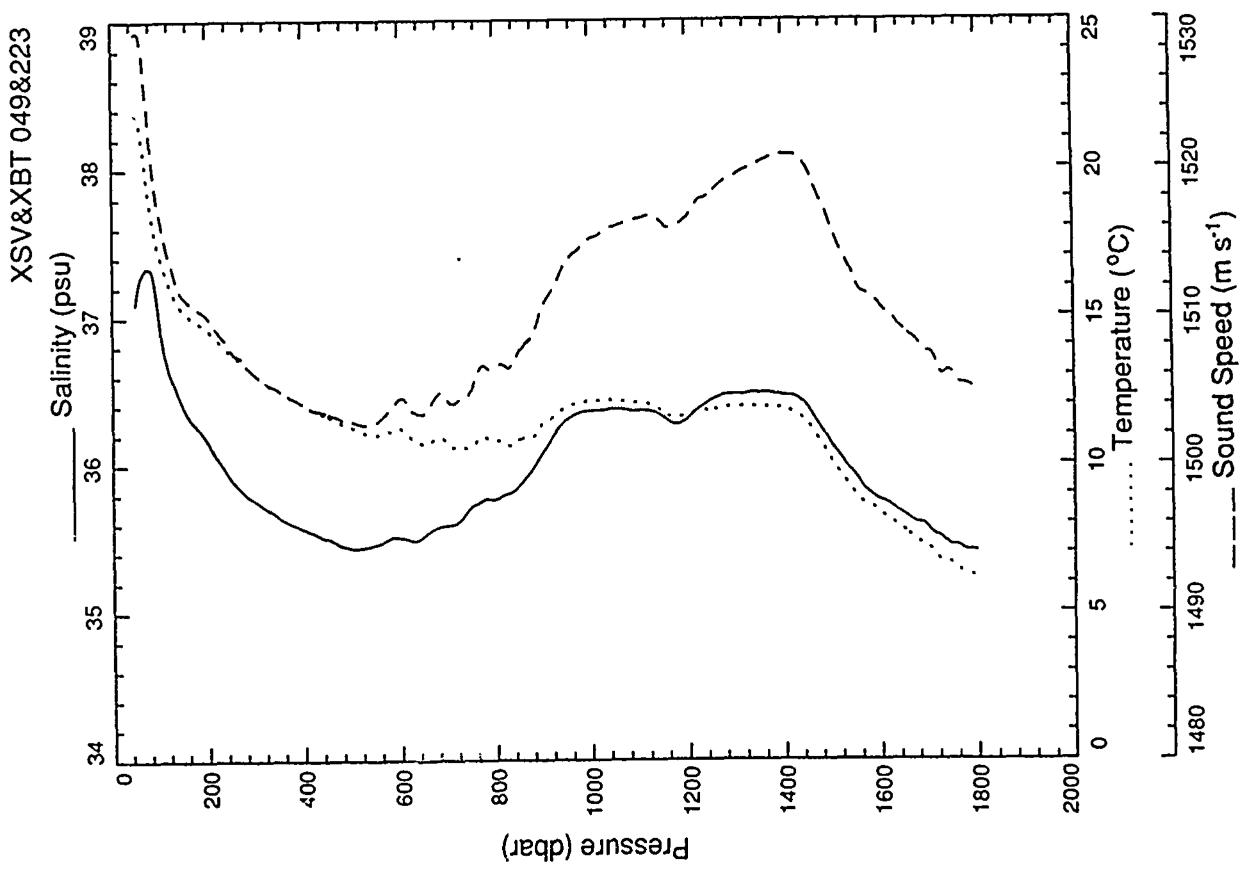


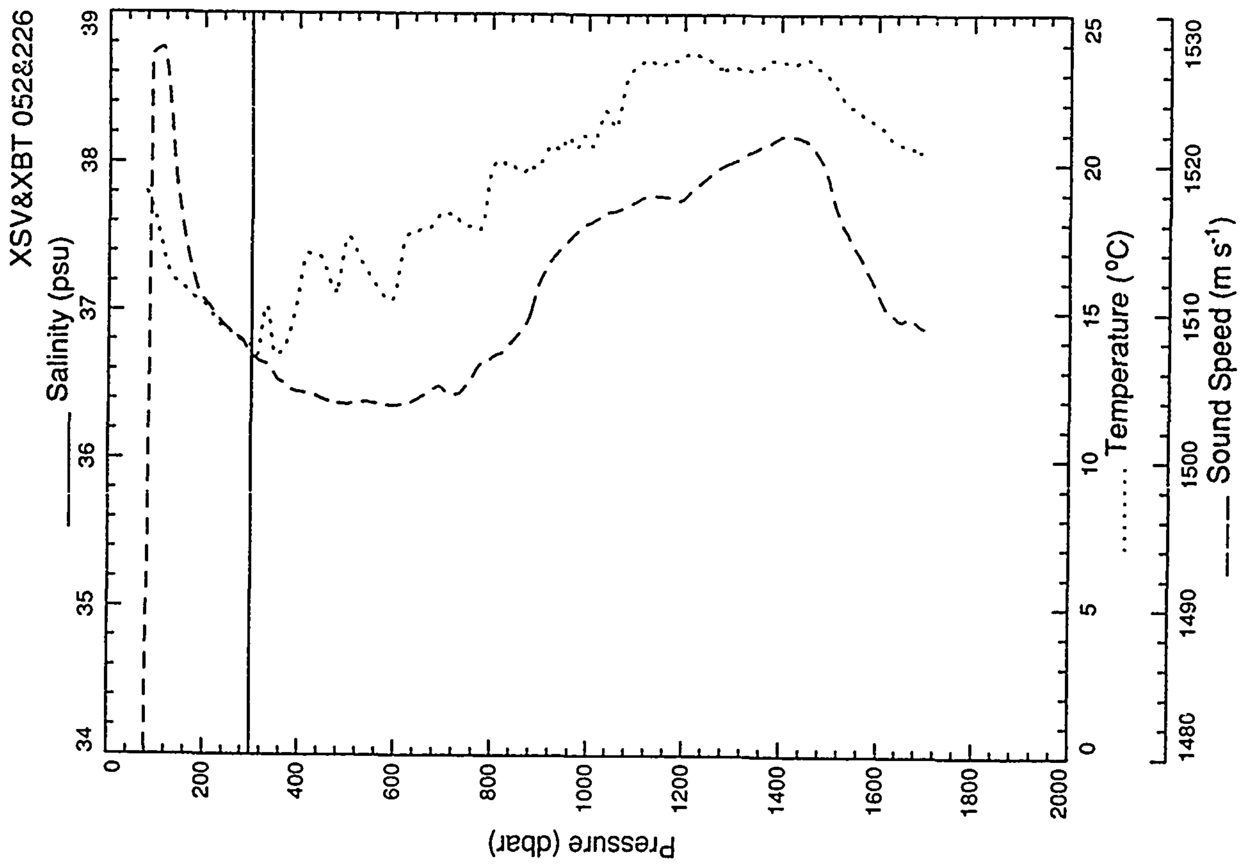
XSV&XBT 045&219
Salinity (psu)
34 35 36 37 38 39
Temperature (°C)
0 5 10 15 20 25
Sound Speed (m s-1)
1480 1490 1500 1510 1520 1530
Pressure (dbar)
0 200 400 600 800 1000 1200 1400 1600 1800 2000

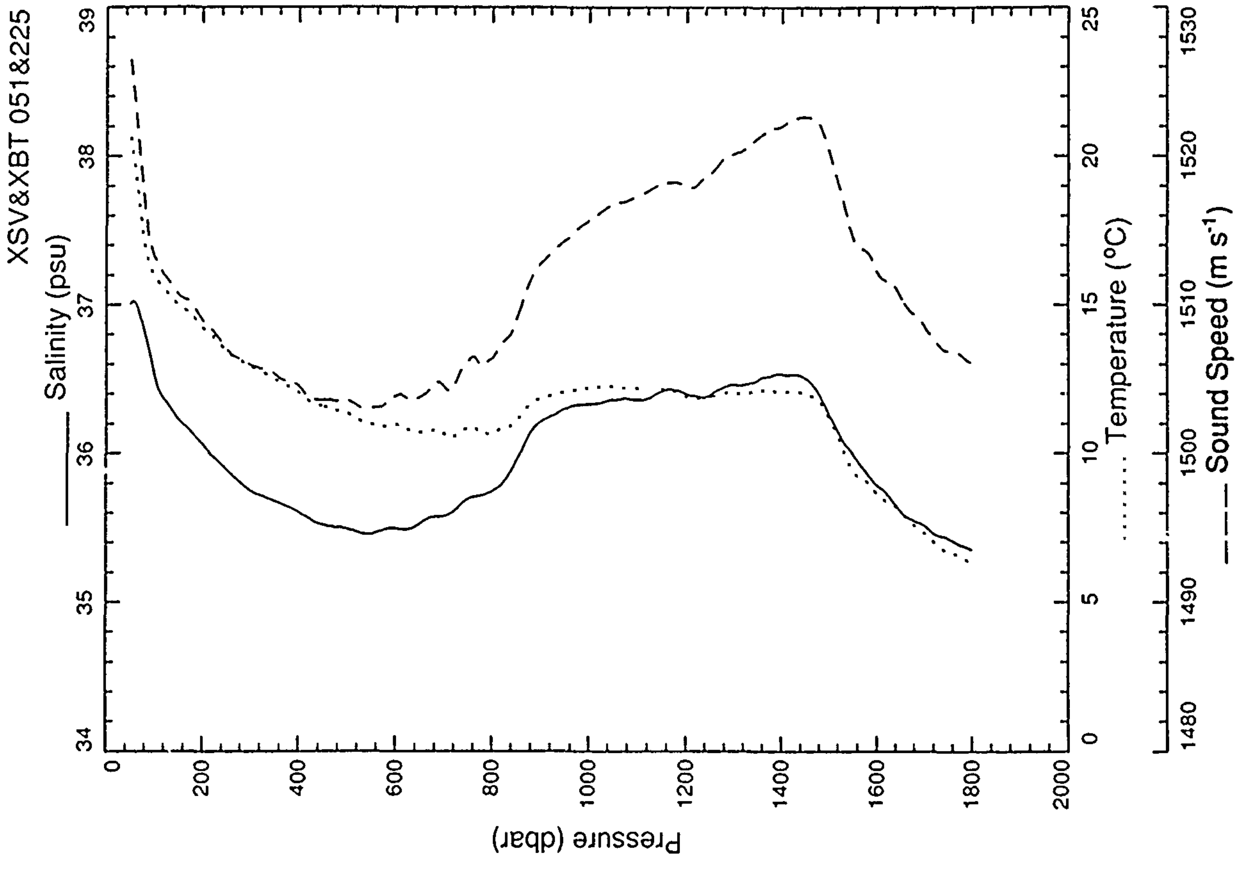

XSV&XBT 048&222
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

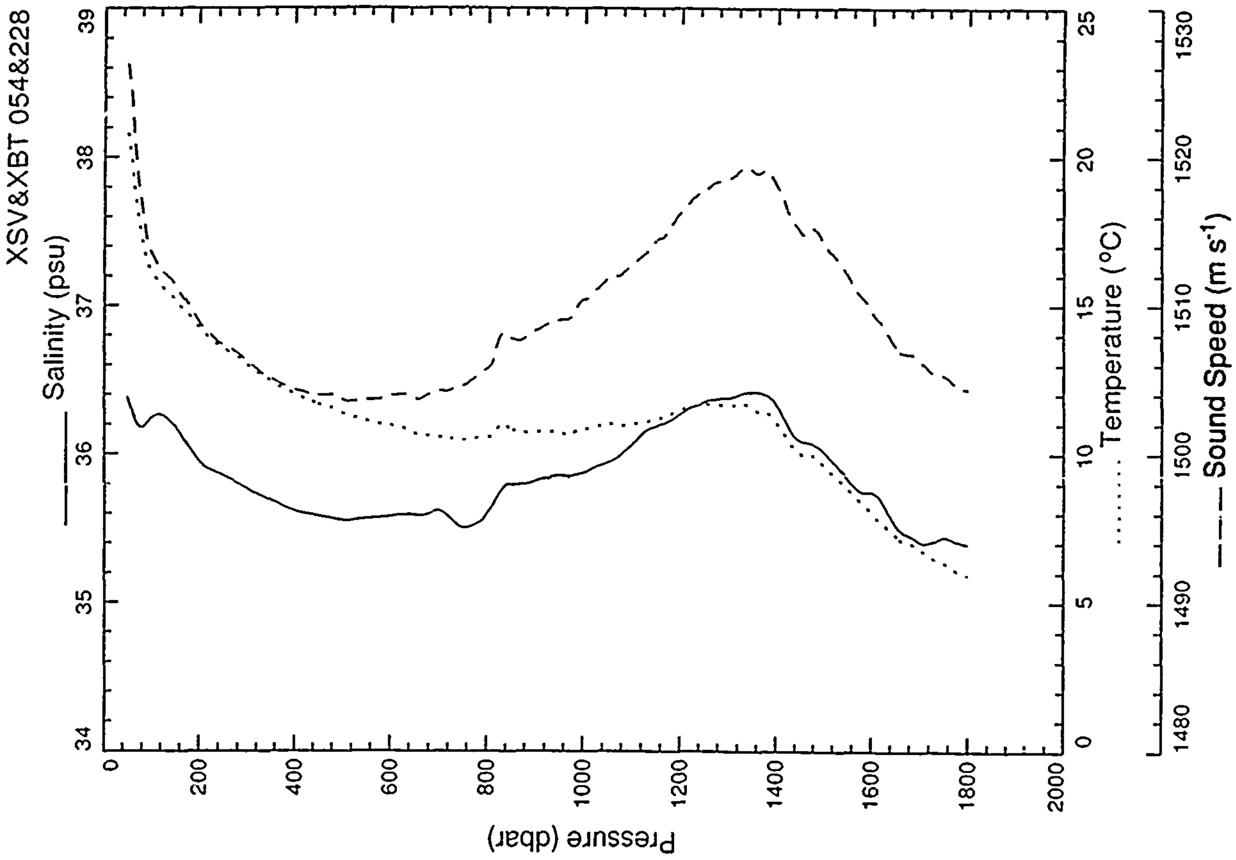

XSV&XBT 047&221
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

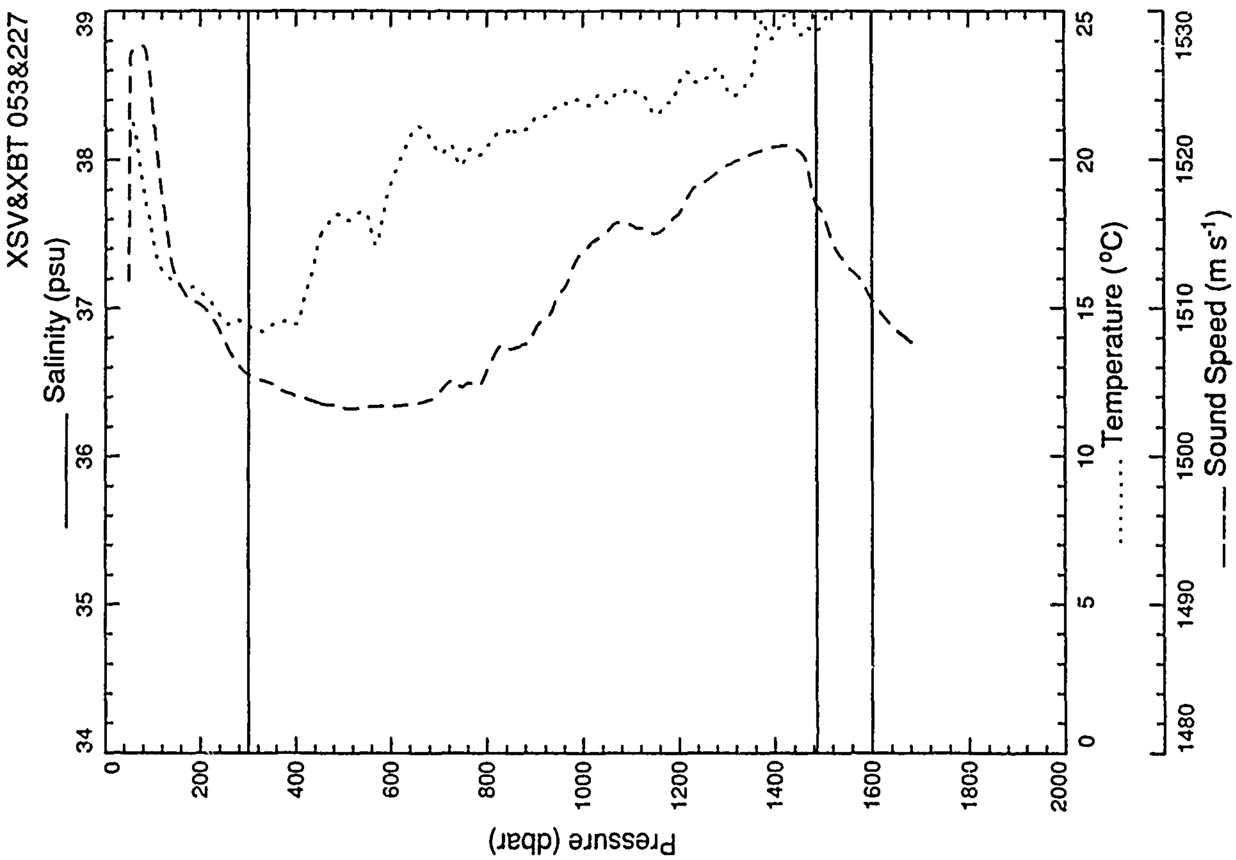

XSV&XBT 050&224
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)

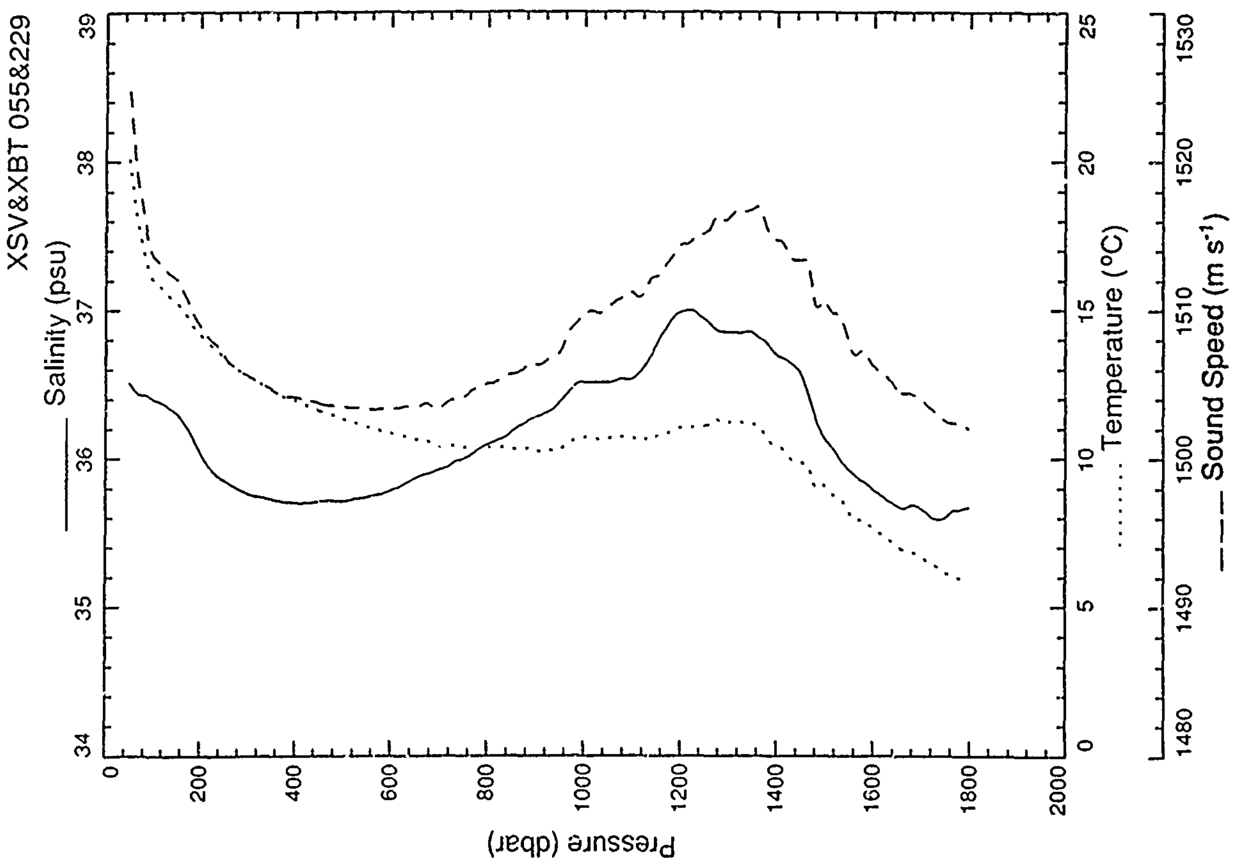

XSV&XBT 049&223
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 052&226
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 051&225
Salinity (psu)
Temperature (°C)
Sound Speed (m s-1)
Pressure (dbar)


XSV&XBT 054&228
Salinity (psu)
Temperature (°C)
Sound Speed (m s⁻¹)
Pressure (dbar)
34 35 36 37 38 39
0 5 10 15 20 25
1480 1490 1500 1510 1520 1530
0 200 400 600 800 1000 1200 1400 1600 1800 2000


XSV&XBT 053&227
Salinity (psu)
Temperature (°C)
Sound Speed (m s⁻¹)
Pressure (dbar)
34 35 36 37 38 39
0 5 10 15 20 25
1480 1490 1500 1510 1520 1530
0 200 400 600 800 1000 1200 1400 1600 1800 2000


XSV&XBT 055&229
Salinity (psu)
Temperature (°C)
Sound Speed (m s⁻¹)
Pressure (dbar)
34
35
36
37
38
39
0
5
10
15
20
25
1480
1490
1500
1510
1520
1530
0
200
400
600
800
1000
1200
1400
1600
1800
2000

APPENDIX F

Algorithm for Computing Salinity from Temperature, Sound Speed, and Pressure

Chen and Millero (1977) give an empirical relation for computing the sound speed in seawater from the measured values of the seawater temperature, salinity, and pressure. To estimate the salinity of the seawater from measured values of sound velocity, temperature, and pressure, their relation is inverted, so that salinity is found as a function of the other three variables. Chen and Millero (Eq. 4) give

$$(U^P - U^P_{H_2O}) - (U^0 - U^0_{H_2O}) = A\,S + B\,S^{1.5} + C\,S^2$$

where

U^P	=	speed of sound in seawater
$U^P_{H_2O}$	=	speed of sound in pure water
U^0	=	speed of sound in seawater at zero pressure
$U^0_{H_2O}$	=	speed of sound in pure water at zero pressure
S	=	salinity
A, B, C	=	coefficients.

The term $U^0 - U^0_{H_2O}$ is also given as a function of S, $S^{1.5}$, and S^2. Solving for S, the equation can be rearranged as

$$C\,S^2 + B\,S^{1.5} + A\,S - (U^P - U^P_{H_2O}) + (U^0 - U^0_{H_2O}) = 0$$

or

$$S^2 + a\,S^{1.5} + b\,S + d = 0\,.$$

The coefficients a, b, and d are computed from parameters given by Chen and Millero.

The following is a function written in C which, when given values of sound speed, temperature, and pressure, will return a value of salinity obtained by numerically solving the above equation. The program that calls the function is not given.

```
/*
**      "sfsvel.c"
**
**      Source          :       C.-T. Chen and F.J. Millero (1977)
**                              Journal of the Acoustic Society of America
**                              Vol 62, pp 1129-1135.
**                              ( inversion of their equations )
**
**      Check values    :       sfsvel( 1521.46, 20.,    0 ) = 35.0
**                              sfsvel( 1506.34, 10., 1000 ) = 35.0
**                              sfsvel( 1503.87,  5., 2000 ) = 35.0
*/

/* -- Equation (4) in Chen and Millero is

  ( u - u_pure ) - ( u0 - u0_pure ) = A*S + B*S^1.5 + C*S^2

   where u       = speed of sound in seawater water,
         u_pure  = speed of sound in pure water,
         u0      = speed of sound in seawater at zero pressure,
         u0_pure = speed of sound in pure water at zero pressure,
         S       = salinity, and
         A,B,C   = coefficients

   Solving for S, the equation can rearranged as

   C*S^2 + B*S^1.5 + A*S - ( u - u_pure ) + ( u0 - u0_pure ) = 0.

   or       S^2  +  a*S^1.5  +  b*S  +  d  =  0

*/

# include "math.h"

# define EPS1   1.0e-06
# define EPS2   1.0e-10

double sfsvel( u, t, p )

double u;       /* sound velocity in m/s */
double t;       /* temperature in deg. C */
double p;       /* pressure in dbars */
{

   double sqrt();
   double u_pure;
   double a, b, d, factor, S, s1, s2, s3, s3_old, f0, f1, f2, f3;
   int flag = 1;

   /* ------ initialize parameter coefficients -------- */

   double u1  =  1402.388,     u2  =  5.03711,     u3  = -5.80852e-2;
   double u4  =  3.3420e-4,    u5  = -1.47800e-6,  u6  =  3.1464e-9;
   double u7  =  0.153563,     u8  =  6.8982e-4,   u9  = -8.1788e-6;
   double u10 =  1.3621e-7,    u11 = -6.1185e-10,  u12 =  3.1260e-5;
   double u13 = -1.7107e-6,    u14 =  2.5974e-8,   u15 = -2.5335e-10;
   double u16 =  1.0405e-12,   u17 = -9.7729e-9,   u18 =  3.8504e-10;
   double u19 = -2.3643e-12;

   double d1  =  1.389,        d2  = -1.262e-2,    d3  =  7.164e-5;
   double d4  =  2.006e-6,     d5  = -3.21e-8,     d6  = -1.922e-2;
   double d7  = -4.42e-5,      d8  =  1.727e-3;

   double a1  =  9.4742e-5,    a2  = -1.2580e-5,   a3  = -6.4885e-8;
   double a4  =  1.0507e-8,    a5  = -2.0122e-10,  a6  = -3.9064e-7;
   double a7  =  9.1041e-9,    a8  = -1.6002e-10,  a9  =  7.988e-12;
```

```
   double a10 =  1.100e-10,   a11 =  6.649e-12,   a12 = -3.389e-13;

   double b1  =  7.3637e-5,   b2  =  1.7945e-7,   c1  = -7.9836e-6;

   /* ----------------------------------------------------------------- */

   p /= 10.;            /* -- convert dbars to bars -- */

   /* -- compute the speed of sound in pure water (Chen & Millero, Eq (3) -- */

   u_pure =     u1  + t*( u2  + t*( u3  + t*( u4  + t*( u5 + t*u6))))
            + ( u7  + t*( u8  + t*( u9  + t*( u10 + t*u11))))*p
            + ( u12 + t*( u13 + t*( u14 + t*( u15 + t*u16))))*p*p
            + ( u17 + t*( u18 + t*u19))*p*p*p;

   factor = c1*p + d8;

   a      = ( d6 + t*d7 ) + ( b1 + t*b2 ) * p;
   a     /= factor;

   b      =     d1 + t*( d2 + t*( d3 + t*( d4 + t*d5 )))
            + ( a1 + t*( a2 + t*( a3 + t*( a4 + t*a5 ))))*p
            + ( a6  + t*( a7  + t*( a8 + t*a9)))*p*p
            + ( a10 + t*( a11 + t*a12 ))*p*p*p;
   b     /= factor;

   d      = u_pure - u;
   d     /= factor;

   /*    Need to solve equation  S^2 + a*S^1.5 + b*S + d = 0 ,
         with the desired root between S = 0 and S = 40.

         Solution is obtained by modified linear interpolation method
         as shown in  "Applied Numerical Analysis (Second Edition)"
         by C.F. Gerald, Addison-Wesley Publishing Company, 1978, 518p.  */

   s1 =  0.;
   s2 = 40.;
   f1 = s1*s1 + a*s1*sqrt( s1 ) + b*s1 + d;
   f2 = s2*s2 + a*s2*sqrt( s2 ) + b*s2 + d;
   f0 = f1;

   s3     = s1;
   s3_old = s2;

   if( f1 != 0. ){
      while( flag == 1 ){
         s3 = s2 - f2*( s2 - s1 )/( f2 - f1 );
         if( s3 < 0. )  return( atof( "-1.e30" ) );    /* -- return bad value */
         f3 = s3*s3 + a*s3*sqrt( s3 ) + b*s3 + d;
         if( f3/f1 < 0. ){
            s2 = s3;
            f2 = f3;
            if( f3/f0 > 0. ) f1 *= 0.5;
         }
         else{
            s1 = s3;
            f1 = f3;
            if( f3/f0 > 0. ) f2 *= 0.5;
         }
         f0 = f3;

         if( fabs( s3 - s3_old ) < EPS1 || fabs( f0 ) < EPS2 ){
            S = s3;
            break;
         }

      }
   }
   return( S );
}
```

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Temperature profiles from expendable bathythermographs (XBTs) and sound speed profiles from expendable sound velocimeters (XSVs) were obtained during leg 1 of the Gulf of Cadiz Expedition, 4-19 September 1988, from R/V *Oceanus*. XBTs and XSVs were deployed around Ampere Seamount and Cape St. Vincent, Portugal. Salinity profiles have been calculated from simultaneously dropped pairs of XBTs and XSVs. This report describes the instrumentation used, discusses data acquisition and processing methods, and presents temperature, sound speed, and salinity profiles.

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